AN ANNOTATED BIBLIOGRAPHY OF CHICKPEA DISEASES 1915-1976

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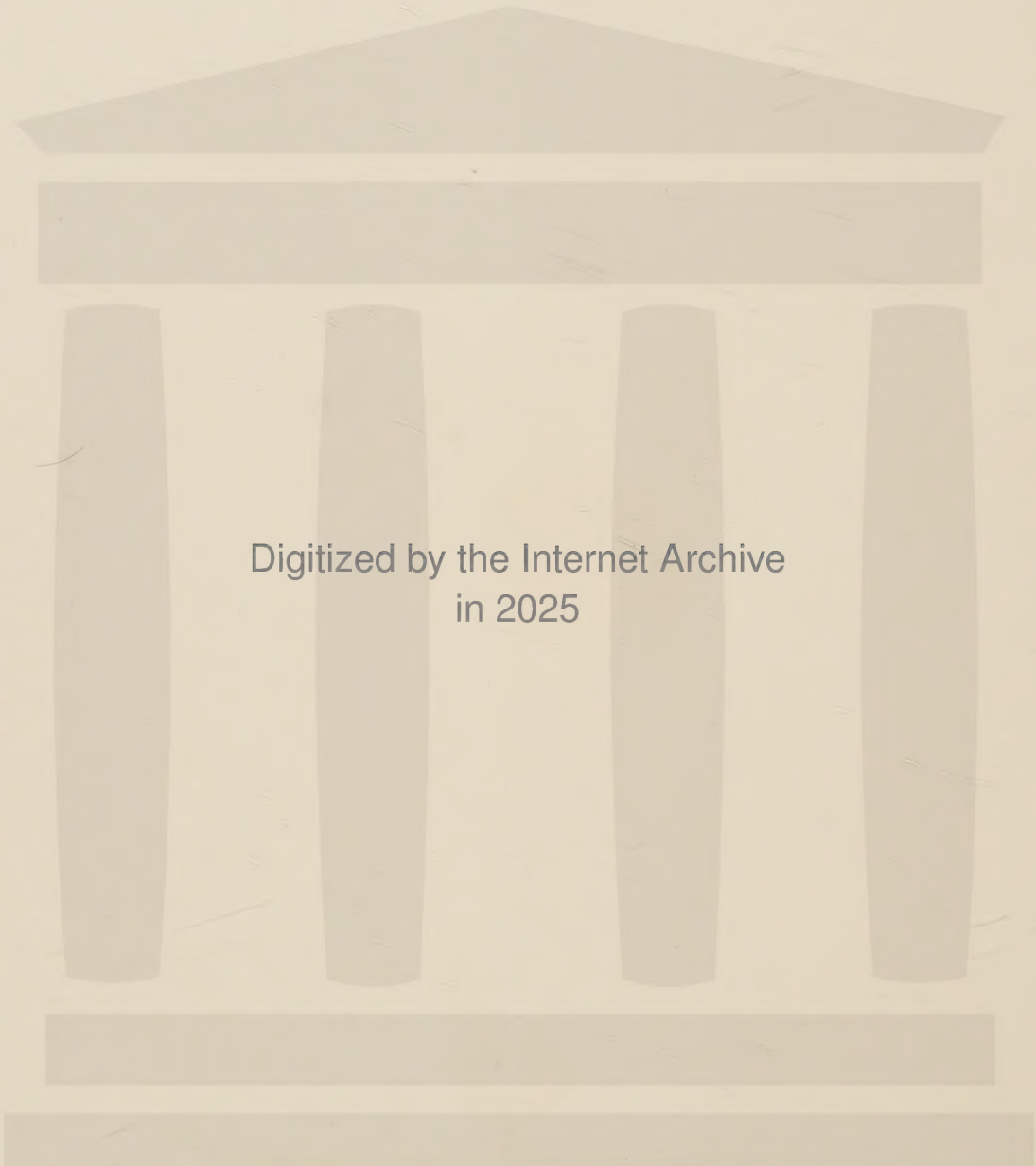

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FOREWORD

Chickpea (*Cicer arietinum*) is a native Asian plant species grown as a pulse crop throughout tropical and subtropical Asia, northern Africa, southern Europe, Central America, and the southern United States. Its seeds are used directly as food, ground into flour, or used as ingredients in curries, soups, and salads. Gram, garbanzo bean, and Spanish pea are other names for the crop.

About 11 million hectares of chickpeas are cultivated annually around the world, with the subsistence farmers of semi-arid India producing more than 75 percent of the crop. Chickpea is a major source of protein for millions of people.

ICRISAT, an international agricultural research institute established in India, has a world-wide mandate for chickpea improvement. It is pleased to be associated with this publication on chickpea diseases. The authors – one Indian, one Ethiopian, and two Americans – have worked together in an international effort to produce a bibliography annotating all the known literature on the diseases of the crop. They hope through its publication to make the literature on chickpea diseases available to scientists throughout the world, and particularly to those scientists in the developing world who do not have ready access to large and well-stocked scientific libraries.

We hope that this publication will lead to faster identification of the various diseases, more concentrated research effort, and more effective control. In the longer term, we hope it will contribute to more stable and productive chickpea crops, and a better way of life for the subsistence farmers of the semi-arid tropics.

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PREFACE

The purpose of this bibliography, on which work began in 1975, is to provide a working file of the literature concerned with chickpea (*Cicer arietinum* L.) diseases that will assist in the identification of fungal and bacterial microorganisms associated with chickpea seeds. Chickpea is one of the more important pulse crops of the Eastern Hemisphere, where it has been cultivated for centuries. The primary function of this bibliography is to make the chickpea disease literature available to agricultural workers throughout the world, especially in countries where such reference material is difficult to obtain.

The annotations, wherever possible, use the authors' original abstracts or summaries with some editing for consistency of style and economy of space. Also abstracts from the *Biological Abstracts* or *Review of Plant Pathology* (*Review of Applied Mycology*) have been included. Papers printed in a language other than English are indicated by brackets enclosing the name of the language used.

The search of literature ended with the December 1976 issues of *Biological Abstracts*, *Phytopathology*, *Plant Disease Reporter*, and *Review of Plant Pathology*, and December 1975 issue of *Indian Phytopathology*. In order to gather as much information as possible, even abstracts of papers presented in conferences/symposia have been included.

Citations are arranged numerically in alphabetical order according to the senior author's last name. Where an author's name appears more than once as sole or senior author, the titles are arranged chronologically without consideration of names of co-authors.

The index is divided into five sections according to the causal agent of the disease: fungi, bacteria, viruses (mycoplasma?), nematodes, and phanerogamic parasite. Other sections deal with seed-borne diseases, chemical control, and miscellaneous information.

This bibliography includes 331 citations from 1915 through 1976. In a publication of this nature, omissions and some inaccuracies are inevitable. We shall appreciate having such omissions brought to our attention.

The fact that only 331 abstracts could be collected in a period of more than 60 years clearly indicates the scant attention paid to the diseases of this crop. The oldest abstract is of a paper published in 1915. The decade-wise classification from 1921 through 1976 is: 1921–30, 23 abstracts; 1931–40, 39 abstracts; 1941–50, 37 abstracts; 1951–60, 56 abstracts; 1961–70, 91 abstracts; and 1971–76, 84 abstracts. This reveals that more attention is being paid to this crop in recent years, and this is a welcome development.

We wish to thank Dr. L. D. Swindale, Director, and Dr. J. S. Kanwar, Associate Director of ICRISAT for their encouragement; Dr. J. M. Green, Pulse Program Leader of ICRISAT for his help; and Dr. R. E. Ford, Head, Department of Plant Pathology, University of Illinois for his encouragement and providing the facilities for the University's contribution to this work. Our special thanks to Mr. P. Rama Murthy, who typed the manuscript, and to Mr. J. W. Spaven, Head, Information Services of ICRISAT, Mr. G. D. Bengtson, Research Editor and their staff for help in publishing this bibliography.

OTHER NAMES OF CHICKPEA

English: Bengal gram, chickpea, gram

French: Pois chiche

German: Kichererbse

Spanish: Garbanzo

Arabic: Homos (Hummos)

Hindi: Chana

Amharic: Shinbra

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Supported in part by the College of Agriculture, University of Illinois Agricultural Experiment Station, Urbana, Illinois 61801, U.S.A.

AN ANNOTATED BIBLIOGRAPHY OF CHICKPEA DISEASES

1. AGA, R. 1966. Physiological and phytopathological studies on the blight of gram caused by *Mycosphaerella rabiei* (Kovacevsky). Ph. D. thesis, Agra University, Agra, India.

2. AHMAD JAMAL. 1976. Studies on the relationship between *Meloidogyne incognita* and behaviour of *Cicer arietinum* roots. Curr. Sci. 45:230–231.

Nematode larvae had gained entry within 3 hours but could not produce visible symptoms on the roots of chickpea. In a period of 6 hours, slight swellings near root tips occurred. Distinct knots could be seen after 24 hours. Knot formations were confined only to root tips and were absent from other portions during this period, although the larval presence was noted in other root zones.

3. AHMAD, T., S. Z. HASANAIN, and A. SATTAR. 1949. Some popular method of plant disease control in Pakistan. Agr. Pakistan 1:18–22.

Survey of plant disease protection in Pakistan. Deals with progress made in breeding resistant chickpea and other crops, crop rotation and sanitation, cultural practices, and chemical control. In addition to the gram cultivar C 62–18, C 12–34 has been found resistant to blight (*Mycosphaerella rabiei*) and only slightly susceptible to wilt (*Fusarium orthoceras* var. *ciceri*).

4. ANONYMOUS. 1931. Plant Pathology (in French) – Rapport sur le fonctionnement de l'Inst. des Recherches Agron. pendant l'annee 1930, 9:411–445.

Infection tests with *Phyllosticta rabiei*, causal organism of anthracnose of chickpea, on 36 types of the host from northern Africa and the south of France resulted in two pure lines of *C. arietinum* var. *album* and one of *C. arietinum* var. *nigrum* being found completely resistant.

5. ANONYMOUS. 1938. Plant diseases. Rep. Dep. Agr. Punjab, 1936–37: 52–56.

During the period under review the chickpea crops in the Attock District of the Punjab (now in Pakistan) was entirely destroyed by blight (*Ascochyta rabiei*) in spite of destruction or burying of all diseased material from previous crops and the sowing of clean seed. These methods had proved completely effective during the previous 3 years, but were nullified on this occasion by fresh infection brought in from neighboring localities by wind and other agencies. No sanitary measures had been adopted in Hazara and Peshawar, and when climatic conditions strongly favor blight, rigorous sanitation cannot save a particular area from subsequent infection from outside tracts where the disease is allowed to develop freely. Three cultivars from France were strongly resistant to the attack and are to be used in breeding work.

6. ANONYMOUS. 1947. Festival publication in honour of the eightieth birthday of Prof. Dr. Otto Appel, P. C., President of the Biological Institute (retired) on the 19th May, 1947 (in German). Biologische Zentralanstalt fur Landund Forstwirtschaft in Berlin-Dahlem. 68 pp.

By means of inoculation experiments, supplemented in some cases by field observations, the host range of *Colletotrichum trifolii* has been extended to include several species including chickpeas.

7. ANONYMOUS. 1947. Report of the Division of Mycology. Sci. Rep. Indian Agr. Res. Inst., New Delhi, 1946–47:109–117.

Fungi isolated from diseased chickpea plants collected in the vicinity of New Delhi included *Fusarium* spp., *Rhizoctonia bataticola* (*Macrophomina phaseoli*), and *Operculella padwickii*; in addition to these, specimens from Karnal harbored *Sclerotium rolfsii*. Plants jointly inoculated with *F. orthoceras*, *M. phaseoli*, *S. rolfsii*, and *O. padwickii* showed typical field symptoms; wilt developed in those inoculated with *F. orthoceras* alone, while the sclerotial fungi caused chlorosis of the lower leaves and shedding of the leaflets, which gradually extended upwards, the bare leaf stalk remaining yellow and stiff. Inoculation with *O. padwickii* alone resulted in chlorosis of the lower leaves; later the leaflets turned brown and folded upwards, while in some cases they dropped and the leaf stalk curved upwards.

The chickpea rust fungus, *Uromyces ciceris-arietini*, could be maintained on the host only upto mid-May on account of increasing heat.

8. ANONYMOUS. 1948. Distribution maps of plant diseases. Maps 145–168. Issued by the Commonwealth Mycological Institute, Kew, Surrey, England.

Map no. 151 shows world distribution of *Ascochyta rabiei* on chickpea.

9. ANONYMOUS. 1949. Annual Administrative Report of the Department of Agriculture, United Provinces, for the year 1947–48. 89 pp.

Chickpea strains at the Central Station of the Agricultural Institute suffered considerably from anthracnose (*Ascochyta rabiei*) after a wet spring, 10 lines being completely destroyed. Lines 99/21, 21, and 142 showed some resistance, yielding 7, 8,

and 13 q/ha compared with 0 to 3 or 4 q/ha for other cultivars.

10. ANONYMOUS. 1949. Annual Administrative Report of the Department of Agriculture, United Provinces, for the year 1947–48. 89 pp.

Wilt of chickpea, in which a number of (unspecified) pathogenic fungi seem to be involved, is becoming serious in the United Provinces. Late cultivars were very susceptible to rust (*Uromyces ciceris-arietini*) which, owing to bad drainage, assumed epidemic proportions at the Government Farm, Nawabganj, Bareilly.

11. ANONYMOUS. 1950. Report of the Head of the Division of Mycology and Plant Pathology. Sci. Rep. Indian Agr. Res. Inst., New Delhi, 1947–48:145–160.

Much of the information in this report has been noted in other abstracts.

12. ANONYMOUS. 1951. Distribution Maps of Plant Diseases. Maps 217–240. Issued by the Commonwealth Mycological Institute, Kew, Surrey, England.

Map no. 235 shows world distribution of *Uromyces ciceris-arietini* on chickpea.

13. ANONYMOUS. 1952. Report of the Division of Mycology and Plant Pathology. Sci. Rep. Indian Agr. Res. Inst., New Delhi, 1949–50:81–88.

Of the various fungi concerned in the etiology of chickpea wilt, *Fusarium orthoceras* induced typical wilt symptoms in inoculation experiments and *Operculella padwickii* closely similar ones, the incidence of infection in both cases ranging from 53 to 83 percent. Other species isolated from diseased plants, i.e., *Neocosmospora*, *Rhizoctonia* (*Corticium*) *solani*, *R. bataticola* (*Macrophomina phaseoli*), and *Sclerotium rolfsii*, caused different symptoms, the percentage of infection ranging from 5 to 39.

14. ANONYMOUS. 1953. Gram wilt and its control. Indian Council Agr. Res., New Delhi and Indian Fmg. 3:7.

Popular article on symptoms, cause, and control. It is suggested that cause of wilt might be high temperatures at the time of sowing and flowering and lack of soil moisture.

15. ANONYMOUS. 1954. Agricultural Research. Rep. Indian Council Agr. Res. 1951–52:11–53.

Chickpea wilt is ascribed to cultivation methods rather than to fungal pathogens. In Bombay 3 of 48 selections of chickpea showed over 77 percent resistance to wilt.

16. ANONYMOUS. 1954. Report of the Division of Mycology and Plant Pathology. Sci. Rep. Indian Agr. Res. Inst., New Delhi, 1951–52:75–87.

A species of *Pythium*, probably *P. ultimum*, is the cause of seed-rotting of chickpea, a new host record for India. Plants sown in late December were towards the end of March severely wilted by *F. orthoceras* var. *ciceri*.

In a study of the microflora of stored seed, *Alternaria* sp. was common on five cultivars of chickpea. After surface sterilization the predominant isolates were the same, but *Mycogone* sp. was as common as *Alternaria* on chickpea. A seed dressing of 3 in 1000 (0.3%?) GN was effective in preventing pre-emergence injury (to unspecified seedlings).

17. ANONYMOUS. 1959. Stem rot disease in gram: warning to farmers. Farmer Bombay 10(1):12.

No causal fungus is mentioned but from symptoms it appears to be *Sclerotinia* infection. Sanitation and rotation with cereals suggested as preventive measures.

18. ANONYMOUS. 1963. Quarterly Report for October – December, 1962, of the Plant Protection Committee for the South East Asia and Pacific Region. F.A.O. Publ. 15 pp.

Chickpea C.1234 lost its resistance to *Phyllosticta rabiei* in the Punjab, India, in 1950–51, probably owing to a new race of the fungus. A new cultivar, C. 235, has been developed and is being distributed.

19. ANONYMOUS. 1968. Plant Pathology. Rep. Inst. Agr. Res., Ethiopia, Feb. 1966–Mar. 1968:68–89.

The plant pathology section was first established in Nov. 1967. A preliminary survey revealed the occurrence of *Sclerotium rolfsii* on chickpea.

20. ARIF, A. G., and A. JABBAR. 1965. A study of physiologic specialisation in *Mycosphaerella rabiei* Koviceveski *Ascochyta rabiei* (Pass.) Lab. the causal organism of gram blight. W. Pakist. J. Agr. Res. 3:103–121.

Pathogenicity tests with *M. rabiei* on 15 cultivars of chickpea indicated that distinct physiologic races of the fungus do not exist in Western Pakistan, although different isolates showed some cultural and morphological differences.

21. ASKEROV, I. B. 1968. Ascochytosis of chickpea (in Russian). Zashch. Rast., Mosk. 13(3):52–53.

Ascochyta rabiei attacks all cultivars of chickpea, especially at 20–25°C, causing 15 to 83 percent losses in yield. In the steppe belt of Azerbaijan, the pathogen overwinters well. Spraying with 3% colloidal S and 2% thiram increased yield; the use of Granosan (1 to 2 kg/ton) increased seed germination and yield (15–26%) by reducing infection of the seedlings.

22. ASTHANA, R. D. 1957. Some observations on the incidence of *Uromyces ciceris-arietini* (Grognon) Jacz. & Boyer on *Cicer arietinum*. Nagpur Agr. Coll. Mag., 31:20A–20B.

A severe outbreak of rust (*U. ciceris-arietini*) on chickpea occurred in Seoni-Malwa, India, especially on a local cultivar, some crops developing 100 percent infection within 48 hours. The disease had appeared occasionally before, but caused no great damage. All cultivars cultivated proved susceptible. Cause of the epiphytotic is not known.

23. ATANASOFF, D., and I. C. KOVACEVSKI. 1929. Parasitic fungi new for Bulgaria (in Russian). Bull. Soc. Bot. de Bulgarie, Sofia 3:45–52.

In 1928, some fields of chickpea were attacked by *Uromyces ciceris-arietini*, which formed rusty-red uredo sori on both sides of the leaves, and by *Phyllosticta rabiei*; the latter forms on the pods, and occasionally on the leaves and stems, numerous round ochre-yellow to greyish-brown spots, 4 to 5 mm in diameter, with a dark brown margin, bearing black pycnidia up to 74 μ in diameter; the pycnospores are continuous, hyaline, cylindrical with tapering ends or ovoid, and measure 10 to 12 by 4 to 5 μ.

24. AUJLA, S. S. 1960. Further studies on the blight disease of gram (*Cicer arietinum* L.) caused by *Phyllosticta rabiei* (Pass.) Trot. in the Punjab. M.Sc. thesis, Punjab Univ., Chandigarh, India.

25. AUJLA, S. S. 1964. Study on eleven isolates of *Phyllosticta rabiei* (Pass.) Trot., the causal agent of gram blight in the Punjab. Indian Phytopath. 17:83–87.

Description of the cultural characteristics and pathogenic behavior of these isolates from chickpea from different localities.

26. AUJLA, S. S., and P. S. BEDI. 1967. Relative reaction of different varieties of gram to blight disease incited by *Phyllosticta rabiei* (Pass.) Trot. in the Punjab. J. Res. Ludhiana 4:214–216.

Of 189 cultivars of chickpea tested, 11 proved resistant to blight and can be used for breeding highly resistant cultivars of agro-commercial value.

27. AYYAR, V. R., and R. B. IYER. 1936. A preliminary note on the mode of inheritance of reaction to wilt in *Cicer arietinum*. Proc. Indian Acad. Sci. 3:438–443.

From 1931 to 1936 two strains of chickpea consistently showed marked differences in their reaction to the wilt attributed by Narasimhan to a *Fusarium*; strain no. 19 showing from 36 to 48 percent mortality and strain no. 468 from 0.4 to 7 percent. When the strains were crossed, mortality distribution in the progeny indicated that incomplete dominance was involved. Progenies of three families each from the higher and lower mortality classes were studied in F_4, and all three of the latter proved homozygous for resistance, while in the former group two were homozygous for high mortality, and the third was intermediate in distribution. The high proportion of homozygous progeny suggests that wilt reaction is governed by only one pair of factors. Sections of root of the resistant strain 468 showed a thick layer of suberin in the periphery of the cortex, whereas in the susceptible type suberin formation was not marked. Development of the fungus within the host was also very much slower in the resistant than in the susceptible strain. It is concluded that the resistance of strain 468 results from the combined effect of morphological and protoplasmic factors.

28. AZIZ, M. A. 1962. C.727–a new blight-resistant gram variety for Barani areas. W. Pakist. J. Agr. Res. 1:165–166.

The cultivar of chickpea was highly resistant to *Ascochyta* (*Mycosphaerella*) *rabiei*, which usually causes severe damage in West Punjab.

29. BABU, R. R., N. N. R. RAO, and M. S. PAVGI. 1975. *Ozonium* wilt of crops in Varanasi. Curr. Sci. 44:512–513.

Plants of several crops including *Phaseolus aureus*, *P. mungo*, cowpea, chickpea, oats, barley, flax, and potato were infected by *O. texanum* var. *parasiticum* when soil moisture was near saturation and temperature moderately high (28–30°C). Affected plants wilted and died; the causal fungus grew profusely over the dead stems and branches with whitish, rope-like mycelial strands on which minute sclerotia eventually formed. All, except potato and chickpea, are new host records; this is the first report of this disease from Uttar Pradesh.

30. BAHADUR, P., and S. SINHA. 1970. Physiologic specialisation in *Uromyces ciceris-arietini*. Indian Phytopath. 23:626–628.

In 1964–65 reactions to seven collections of this rust were studied on 85 cultivars of chickpea. In 1965–66 and 1966–67, 10 cultivars, which gave marked differences in infection types (resistant to susceptible) and four leguminous weeds were tested with 12 other collections of the fungus. The existence of physiologic specialization was demonstrated.

31. BAHADUR, P., and S. SINHA. 1970. Studies on spore germination of *Uromyces ciceris-arietini*: Influence of leaf exudates of gram. Indian Phytopath. 23:644–649.

About 30 percent inhibition was noticed in exudates of Nandriyal 49 chickpea and 10 percent in Agra local. Malic acid at 1000μg/ml reduced uredospore germination to 2.19 percent, but sucrose was stimulatory. Exudates from aging leaves of Nandriyal 49 reduced spore germination, whereas those from similar leaves of Agra local increased it.

32. BAHL, N., and J. S. GREWAL. 1973. Studies on physiology of *Operculella padwickii* causal organism of foot rot of *Cicer arietinum*. Indian Phytopath. 26:622–629.

Best growth and excellent sporulation of *Operculella padwickii*, the causal organism of foot rot of chickpea, was recorded on modified Asthana and Hawker's medium containing 2 g of potassium nitrate.

O. padwickii was grown on this medium at temperatures 15 to 35°C and pH levels 3.2 to 5.0. Maximum growth and good sporulation was recorded at 25°C and pH 4.4. Growth of the fungus increased with increase of glucose in the medium, but sporulation decreased progressively. Of 15 carbon sources, D-glucose was found to be the best source of carbon for growth and sporulation: starch and sucrose were the next best sources.

O. padwickii was also grown on 8 inorganic salts and 20 amino acids. Among inorganic salts, calcium nitrate supported best growth. Nitrates of calcium, magnesium, sodium, and potassium induced excellent sporulation. Among amino acids, L-leucine, glycine, L-arginine, and DL-methionine supported good growth. L-cystine and L-cystein were not utilized. In general sporulation was absent or was poor to fair on various amino acids.

33. BAHL, N., and J. S. GREWAL. 1974. Efficacy and synergism of fungicides against *Operculella padwickii*. Indian Phytopath. 27:126–129.

In vitro tests revealed that all organomercurials, copper oxinate, thiram, and carboxin (Vitavax) inhibited fungus growth at 100 μg/ml. However some of the mercurials were equally effective at 10 μg/ml. Synergistic effect between two mercurials – coromerc and New Improved Ceresan – was observed.

34. BAHL, N., and J. S. GREWAL. 1974. Effect of trace elements on growth and sporulation of *Operculella padwickii*. Indian Phytopath. 27:413–415.

In vitro studies on the influence of trace elements on growth and sporulation of *O. padwickii*, causal organism of the foot rot of chickpea, revealed growth was best when all trace elements were present. It was reduced considerably in the absence of zinc sulphate, uranyl acetate, and manganese sulphate. Sporulation was excellent without cupric sulphate.

35. BAHL, N., and J. S. GREWAL. 1975. Influence of vitamins on growth and sporulation of *Operculella padwickii*. Indian Phytopath. 28:429–430.

In laboratory studies, pyridoxine, biotin, and riboflavin stimulated growth whereas pyriodoxine and phthicol stimulated sporulation.

36. BEDI, K. S. 1956. A simple method for producing apothecia of *Sclerotinia sclerotiorum* (Lib.) de Bary. Indian Phytopath. 9:39–43.

At the Government Agricultural College and Research Institute, Ludhiana, Punjab, India, apothecia of *Sclerotinia sclerotiorum* isolated from chickpea were produced from floating sclerotia in water in a covered dish or loosely plugged vessel at a temperature of 15 to 20°C in good light.

37. BEDI, K. S., and D. S. CHAHAL. 1958. No stem rot control, no gram. Indian Fmg. 8 (6):6–7.

A popular article on stem rot caused by *Sclerotinia sclerotiorum*. Authors describe their observations on symptoms and etiology. Control measures such as sanitation, use of sclerotia-free seed, deep plowing, and rotation with cereals like wheat, barley, and oats have been suggested.

38. BEDI, K. S. 1961. Outbreak of gram blight in Punjab in 1958–59. Plant Prot. Bull. 12:24–25.

Severe epiphytotic of the blight is reported and measures to reduce it in future suggested.

39. BEDI, K. S., and D. S. ATHWAL. 1962. C 235 is the answer to blight. Indian Fmg. 12 (9):20–22.

C 235 is claimed to be blight resistant and recommended to replace C 1234 (F8 × Pb 7) which was resistant until 1950–51.

40. BEDI, K. S. 1963. The age and the size of sclerotia of *Sclerotinia sclerotiorum* (Lib.) de Bary in relation to the formation of apothecia. J. Indian Bot. Soc. 42:204–207.

Sclerotia of this isolate from chickpea had only a short period of dormancy and this was lost with age; delay in germination of sclerotia stored dry and then floated on water was 19 days in those 6 weeks 5 days old, and 9 days in those of 9 weeks 5 days. Number of apothecia was correlated with size, i.e., one apothecium from a 1 × 1 mm sclerotium and 15 from one 13 × 5 mm in size.

41. BEDI, P. S., and S. S. AUJLA 1969. Variability in *Phyllosticta rabiei* (Pass.) Trott., the incitant of blight disease of gram. Punjab J. Res. Punjab Agr. Univ. 6:103–106.

Variation in *Phyllosticta rabiei*., the incitant of chickpea blight in the Punjab, was studied under controlled conditions. On the basis of symptomatology, manner of pycnidial formation on the host, and pathogenic behavior, it is confirmed that *P. rabiei* as it occurs in the Punjab is composed of several physiologic races. To locate the sources of resistance against blight, it is suggested that breeding material be tested against all physiologic races prevalent in the area.

42. BEDI, P. S., and S. S. AUJLA. 1970. Factors affecting the mycelial growth and the size of pycnidia produced by *Phyllosticta rabiei* (Pass.) Trot. the incitant of gram blight in the Punjab. J. Res. Ludhiana 4:606–609.

Pycnidia of *P. (Ascochyta) rabiei* developed best at pH 7.6 and 8.6, 20° C, and double the concentration of nutrients in Richards' medium. Hyphal growth was maximum at pH 6.4, 25° C, and half the concentration of nutrients.

43. BENLLOCH, M., and J. DEL CANIZO. 1931. The anthracnose of chickpeas (in Spanish). Bol. Pat. Veg. Ent. Agr. V, 19–22:128–133.

A popular account of the symptoms and biology of anthracnose [*Phyllosticta (Ascochyta) rabiei*] of chickpeas in Spain, with recommendations for its control.

44. BENLLOCH, M. 1941. Some phytopathological characteristics of the year 1941 (in Spanish). Bol. Pat. Veg. Ent. Agr., Madr. X, 29–32:1–14.

Weather conditions in 1941 were conducive to an intensive outbreak of chickpea blight [*Phyllosticta (Ascochyta) rabiei*] in the Andalusian provinces, where the crop in many cases was a total loss. In the province of Burgos, heavy rains impeded spring sowing and cold temperatures retarded vegetative development. Heavy losses were observed.

45. BENLLOCH, M. 1949. Phytopathological observations in the year 1948 (in Spanish). Bol. Pat. Veg. Ent. Agr. Madr. 16:203–242.

Chickpea plantings were largely destroyed, especially in Andalusia by *Fusarium* and *Phyllosticta (Ascochyta) rabiei.*

46. BHAGWAGAR, P. R. 1940. Studies on *Fusarium* wilt and seed rot of gram (*Cicer arietinum* L.) in India. Part 2 of Assoc. I.A.R.I. thesis, Indian Agr. Res. Inst., New Delhi. 103 pp.

47. BHELWA, P. W. 1962. Seed decay, seedling blight, and root rot of *Cicer arietinum* caused by *Phytophthora cryptogea*. Diss. Abstr. 23:389–390.

At Ohio State Univ., single zoospore cultures of three isolates of *P. cryptogea* – one from Calif. and two from Ohio – differed in pathogenicity; two differed in their ability to utilize N compounds. Optimum mycelial growth occurred between 20 and 25° C. Three isolates of *P. parasitica* (from tomato, peperomia, and gloxinia) were pathogenic to chickpea. In a host-range investigation of *P. cryptogea* on 17 cultivars and species of plants, symptoms in general did not develop on mature plants (exceptions were Lincoln soybean and Laxton pea). Seed decay and preemergence damping-off did occur with some cultivars and species. Disease incidence was least in the oldest plants (4-weeks' old when inoculated) and much more severe when inoculum was placed at the crown of chickpea plants than on or near the roots. Seed treatment with captan or thiram gave the best control of seedling blight. Use of SD345 (2-propene-1, 1-diol diacetate) as soil treatment was effective in controlling the disease at 50, 100, and 200 μg / ml, the best being 100 μg / ml at 100 ml given twice at a week's interval before sowing.

48. BIGGS, C. E. G. 1944. Annual Report, Department of Agriculture, Tanganyika Territory, 1943. 8 pp.

Ascochyta rabiei, not before recorded in Tanganyika, caused severe loss in chickpea fields in the Lake Province.

49. BONDARTZEVA-MONTEVERDE, Mme V. N., and N. I. VASSILIEVSKY. 1940. A contribution to the biology and morphology of some species of *Ascochyta* on Leguminosae (in Russian). Acta Inst. Bot. Acad. Sci. U.S.S.R., 1938, Ser. II:345–376.

Artificial-infection experiments carried out from 1930 to 1932 at the Botanical Institute of the U.S.S.R. Academy of Sciences showed that, among the species of *Ascochyta* parasitic on *Leguminosae*, some are specialized on one host and some are capable of infecting many. To the former group belong *A. fabae* on broad-beans (*Vicia faba*), *A. pisi* on peas, *A. rabiei* on chickpea, and *A. lentis* n. sp. (with a Latin diagnosis) on sainfoin (*Onobrychis sativa*). All produce severe infection only on their specific hosts.

50. BREMER, H. 1944. On wilt diseases in south-west Anatolia (in German). Istanbul Yaz. 18:40.

Ascochyta pinodella was responsible for wilt and black-leg of broad-beans and peas. A *Fusarium* sp. and a *Cephalosporium* were isolated from necroses in the root system of chickpea with pallid stem bases to which dark, irregular, scab-like lines and depressions imparted a "cauterized" appearance.

51. BUSHKOVA, Mme L. N. 1960. Susceptibility of chickpea varieties to ascochytosis (in Russian). Zashch. Rast., Mosk. 5:55.

In summer 1953 almost all cultivars of chickpea at the Krasnodar State Selection Station were infected by *Ascochyta rabiei*. Of the 273 cultivars grown, Kubanskii 16 (which was taken as the standard), Krasnokutskii 195, Krasnogradskii 1, Ustoichivyi 2, and Askokhitous-toichivyi 1 were comparatively resistant. Mild infection occurred on Crimean, Dnepropetrovsk, and some Bulgarian and Indian cultivars. Work for the production of resistant cultivars continues.

52. CARRANZA, J. M. 1965. Wilt of chickpea (*C. arietinum*) caused by *B. cinerea* (in Spanish). Revta Fac. Agron. Univ. Nac. La Plata 41:135–138.

The disease has caused 95 percent losses in Jujuy Province. Symptoms are largely confined to the crown, where dark brown necrotic lesions that can encircle the stem appear, giving rise to 3- to 4-mm cankers. Small lesions 1 to 2 mm in diameter appear on the lower shoots, followed by leaf-fall.

53. CHAHAL, D. S. 1964. Studies on the stem-rot disease of gram (*Cicer arietinum* L.) caused by *Sclerotinia sclerotiorum* (Lib.) de Bary in the Punjab. M.Sc. thesis, Punjab Agr. Univ., Ludhiana, India.

54. CHANDRA, S., and Y. S. TOMER. 1973. Some aspects of incidence of wilt disease in Bengal gram with special reference to Haryana state. Symposium on wilt problem and breeding for wilt resistance in Bengal gram. September 1973 at Indian Agr. Res. Inst., New Delhi, India. p. 8 (Abstr.).

Factors responsible for occurrence of wilt disease in Haryana are numerous. While some studies on pathogenic aspects of the disease are not very revealing, certain others demonstrate the effects of temperature, moisture level, variety, crop rotation, soil type, time and method of sowing, etc. A reasonable degree of repeatability in agronomic manipulation of wilt incidence shows these factors to be important. Absence of high degree of repeatability shows that pathogen, the incontrollable factor, is also very important. Perhaps a fungicide (soil application) might be helpful in controlling disease. Includes suggestions to minimize field incidence of wilt disease.

55. CHANDRA, S., Y. S. TOMER, and B. P. S. MALIK. 1974. Aspects of wilt disease in gram with special reference to Haryana state. Indian J. Genet. & Plant Breeding 34:257–262.

Much work is needed in standardizing development of wilt-sick plots, using adequate ingredients, particularly the pathogen. *Rhizoctonia* as an important factor of early damage in chickpea should receive pointed attention and need not be mixed with other wilt-causing organisms. A distinction between laboratory resistance to a single virulent race of wilt-causing organism and field tolerance may be necessary, because the latter takes care of the interaction between pathogen and several other important factors. Data obtained in Haryana, although not entirely consistent, show the contributions of other agroclimatic and genotypic factors.

The high contribution of initial moisture alone, almost to an extent of about 90 percent of average yield, indicates a method of checking wilt by application of a pre-sowing irrigation wherever possible. This practice is being recommended in those regions of Haryana which have recently benefitted from lift-irrigation schemes. Also there is a great scope of exploiting other agronomic variables in enhancement of production by minimizing wilt incidence. Screening of genotypes for wilt tolerance in gram will perhaps become more efficient through simultaneous screening for drought tolerance, salinity tolerance, and even tolerance to micronutrient deficiency – as for zinc.

The tolerant and resistant types isolated in different parts of the country should be more extensively used for breeding purposes through exchange of material. There is need for critical experimental evaluation of the various wilt contributing factors in different gram cultivation zones so as to help overcome the serious problem of gram wilt in the country.

56. CHATTOPADHYAY, S. B., and P. K. SEN GUPTA. 1967. Studies on wilt diseases of pulses. I. Variation and taxonomy of *Fusarium* species associated with wilt disease of pulses. Indian J. Mycol. Res. 5:45–53.

From a study of monoconidial isolates from chickpea, lentil, and pigeonpea it is proposed that *F. orthoceras* f. sp. *ciceri* and *lentis* should be renamed *F. oxysporum* f. sp. *ciceri*, and *lentis*, respectively.

57. CHAUHAN, L. S., and B. K. SINGH. 1966. Effect of fungicides on the growth of *Ascochyta rabiei*, causal organism of gram blight. Labdev J. Sci. Tech. 4:57–58.

Aretan at 300 μg/ml and Ceresan wet at 2,000 μg/ml gave 100 percent control on chickpea.

58. CHAUHAN, R. K. S. 1966. *In vitro* production of toxic metabolites by *Ascochyta rabiei* (Pass.) Lab. inciting blight of gram (*Cicer arietinum* L.). Proceedings of the symposium on the physiology of fungi, held at Chandigarh. Bull. Natn. Inst. Sci. India 35:120–127.

59. CHAUHAN, R. K. S. 1968. Metabolic and nutritional considerations of blight of gram, *Cicer arietinum* L., caused by *Ascochyta rabiei* (Pass.) Lab. Ph.D. thesis, Agra University, Agra, India.

60. CHAUHAN, R. K. S., and S. SINHA. 1973. Effect of varying temperature, humidity, and light during incubation in relation to disease development in blight of gram (*Cicer arietinum*) caused by *Ascochyta rabiei*. Proc. Natn. Sci. Acad., India. B. 37:473–482.

In glasshouse trials, the optimum temperature for expression of symptoms and sporulation was 20° C and optimum RH 85 to 98 percent, with an incubation period of 144 h. No symptoms were noted at 10° and 30°. A minimum of 84 h of optimum RH was necessary for disease appearance. In young plants, lesions were larger and symptoms appeared sooner. Under continuous light, lesions were smaller and sporulation was markedly reduced.

61. CHAUHAN, S. K. 1956. Varietal resistance of gram to Fusarium wilt. Proc. Indian Sci. Congr. 43:216.

Four lines were screened in pots containing soil inoculated with *F. orthoceras*. Not one of the lines was resistant, but the author suggested that pot screening should be done to identify resistance.

62. CHAUHAN, S. K. 1956. Observations on certain soil conditions affecting Fusarium wilt of gram. Proc. Indian Sci. Congress 43:217.

This is an abstract stating that there was an interaction between pH, moisture, and organic matter and this influenced the wilt incidence (See abstract no. 74).

63. CHAUHAN, S. K. 1959. Studies on wilt of gram and crop-loss estimates. Ph.D. thesis, Agra University, Agra, India.

64. CHAUHAN, S. K. 1960. A technique for disease appraisal and loss estimations in Fusarium wilt of gram. Agra Univ. J. Res. 9:253–260.

A preliminary investigation of wilt of chickpea caused by *Fusarium orthoceras* var. *ciceri*, with reference to disease intensity and crop loss in the two fields in Bichpuri Farm, Agra, India. A technique to measure the disease intensity by reducing the visual observation of the symptoms to a quantitative index, depending upon the period and amount of wilting, was developed.

65. CHAUHAN, S. K. 1961. Toxin production by *Fusarium orthoceras* var. *ciceri* causing wilt of gram. Proc. Nat. Acad. Sci. India. Sect. B. 31:341–348.

At the Bot. Dept., Agra College, maximum toxin production was obtained after 30 days in Richards's medium at 28 to 31° C. Boiled and nontreated filtrates both caused wilting of chickpea in 36 h. Addition of 25 μg/ml ambramycin and 50 ppm chloromycetin delayed the time for toxin-induced wilt from 36 h in the nontreated to upto 132 h.

66. CHAUHAN, S. K. 1962. Influence of pH in sand cultures on disease intensity and crop loss correlation in Fusarium wilt of gram (*Cicer arietinum* L.). J. Indian Bot. Soc. 41:220–225.

From the study it appears that alkaline reaction of the soil is favorable to growth of the plants, seed yield, and seed number. Disease intensity increases with lowering of pH and decreases with increase in pH, being considerably low at pH 9.2. Thus there is a possibility of checking the disease without affecting crop growth and yield, by altering the soil pH.

67. CHAUHAN, S. K. 1962. A note on soil reaction in relation to Fusarium wilt of gram (*Cicer arietinum* L.). Proc. Nat. Acad. Sci. India B. 32:385–386.

In further studies at Agra College, plant mortality from *F. orthoceras* f. sp. *ciceri* was influenced by pH regardless of soil condition. In sterilized soil, mortality was low at pH 7.8 and 9.2, and in acidic ranges it either equalled or surpassed that in the neutral range (7.1), but in nonsterilized soil it was high at high pH and low at low pH.

68. CHAUHAN, S. K. 1962. Fusarium wilt of gram (*Cicer arietinum* Linn.) in relation to organic matter of soil. Influence of soil texture on the incidence of Fusarium wilt of gram (*Cicer arietinum* Linn.) (in Hindi). Vignana Parishad Anusandhan Patrika 5(2):73–76; (3):137–139.

In further studies at Bot. Dept., Agra College, mortality of *C. arietinum* from *F. orthoceras* var. (f. sp.) *ciceri* was inversely related to the humus content of the soil. Wilt was most severe on sandy soil and least on a clay-loam soil.

69. CHAUHAN, S. K. 1962. Physiologic variations in *Fusarium orthoceras* App. & Wr. var. *ciceri* Padwick causing wilt of gram (*Cicer arietinum* L.) Proc. Nat. Acad. Sci. India. Sect. B. 32:78–84.

In further studies at Agra College, 22 isolates of *F. orthoceras* var. *ciceri* were placed in three groups on the basis of mycelium and colony type. The isolates varied in pathogenicity and there was a significant correlation between the toxicity of the toxin and virulence. On the basis of filtrate toxicity and percent mortality in pot inoculations, five groups were segregated.

70. CHAUHAN, S. K. 1962. Observations on certain symptoms in Fusarium wilt of gram (*Cicer arietinum* L.). Agra Univ. J. Res. 11:285–294.

In further studies the earliest symptoms of *F. orthoceras* var. (f.

sp.) *ciceri* was acropetal vein clearing of the leaves, possibly indicating the path of toxin movement. The number of chloroplasts and starch formation in the mesophyll cells decreased. Leaves turned yellow and then drooped. Younger plants were more susceptible.

71. CHAUHAN, S. K. 1963. Incidence of Fusarium wilt of gram in relation to soil moisture. Agra Univ. J. Res. 12:271–274.

F. orthoceras var. (f. sp.) *ciceri* caused 83.33 percent mortality of chickpea at 25 percent soil moisture (on oven-dry weight) and only 13.33 percent at 10 percent.

72. CHAUHAN, S. K. 1963. Influence of different soil temperatures on the incidence of Fusarium wilt of gram (*Cicer arietinum* L.). Proc. Indian Acad. Sci. B. 33:552–554.

Pot tests at 15 to 35°C showed that incidence of *Fusarium orthoceras* f. sp. *ciceri* was maximum at 25° and nil at 15°.

73. CHAUHAN, S. K. 1963. Incidence of Fusarium wilt of gram in oilcakes amended soils. Agra Univ. J. Res. (Sci.) 12:143–146.

Incidence of *F. orthoceras* var. (f. sp.) *ciceri* was significantly reduced by treating soil with groundnut, til (sesame), or mustard oilcake, the last giving the best results (8.33% mortality; nontreated 63.33%).

74. CHAUHAN, S. K. 1965. Interaction of certain soil conditions in relation to the occurrence of Fusarium wilt of gram. Indian J. Agr. Sci. 35:52–56.

The wilt of chickpea caused by *Fusarium orthoceras* var. *ciceri* was studied in relation to the interaction of some soil factors. Two types of soil – with high and low percentage of organic content and with low and high levels of soil moisture – were studied in pots. Mortality was 95 percent in acidic soil with high soil moisture and without organic matter, while it was low in other combinations with acidic soil. Soil moisture and organic matter played significant roles in interactions.

75. CIFERRI, R. 1927. Mycological and phytopathological notes (in Italian). Riv. Patl. Veg. 17:209–294.

At Alba (Piedmont) the author observed soybeans affected with anthracnose caused by an *Ascochyta* morphologically identical with *A. pisi*, except that 20 percent of the spores were uniseptate. These spores germinated less rapidly and in smaller numbers than did normal spores, but the germ tubes of both were similar. As *Phyllosticta rabiei*, which causes anthracnose of chickpea, differs from *A. pisi* mainly in having continuous spores, the author thinks that the one organism may be responsible for the similar diseases of peas, *Cicer*, and soybeans, the septation of the spores varying according to the host.

76. CUBERO, J. I. 1965. Studies on nutrient elements needed and medium conditions demanded by the fungus *P. rabiei* (in Spanish). Bol. Patol. Veg. Ent. Agr. 28:147–182.

Aspects of the physiology of the fungus causing blight of chickpea, with particular reference to N nutrition.

77. DALELA, G. G. 1962. A technique for estimating crop loss in the rust [*Uromyces ciceris-arietini* (Grogn.) Jacz.] of gram (*Cicer arietinum* L.). Agra Univ. J. Res. (Sci.) 11:117–121.

Using the method suggested by Greaney, it was found at Dept. Bot., Agra College, that infection adversely affected shoot dry matter, seed yield, seeds/pod, and pods/plant, but had no effect on 100-seed weight or seed-shoot ratio. Each 10 percent increase in disease intensity caused a mean loss of yield of 0.38 g/plant.

78. DANESH, D., and W. J. KAISER. 1969. Chickpea virus diseases in Iran (in Farsi). Iran J. Pl. Path. 5:50–56.

Chickpeas are infected in the field by four viruses: alfalfa mosaic, bean yellow mosaic, cucumber mosaic, and pea leaf roll. Different species of aphids are responsible for their spread. Except for PLRV, all are mechanically transmissible. None is seed-borne. All have been isolated from other hosts in Iran.

79. DANESH, D., and W. J. KAISER. 1969. Virus diseases of chickpea (*Cicer arietinum*) in Iran. Pulse Improvement Project Seminar Report held at Karaj Agricultural College, University of Tehran & USDA:41–45.

Four distinct viruses – alfalfa mosaic virus, bean yellow mosaic virus, cucumber mosaic virus, and pea leaf roll virus – have been isolated from chickpea in Iran.

80. DAS, G. N., and P. K. SEN GUPTA. 1961. A Stemphylium leaf spot disease of gram. Plant Dis. Reptr. 45:979.

A new form of *S. sarciniforme*, pathogenic to chickpea but not to clover or lupin, is described from the State Agr. Res. Inst., Berhampore, West Bengal, India.

81. DAS, G. P. 1948. Multiple factor experiment, spacings × depths × dates, on the incidence of gram wilt. Assoc. I.A.R.I. thesis, Indian Agr. Res. Inst., New Delhi, India. 72 pp.

82. DAS, S. 1952. Composition of gram plant in relation to its disease symptoms. Ph.D. thesis, Univ. of Calcutta, Calcutta, India.

83. DASTUR, J. F. 1928. Annual Report on the Mycological Section for the year ending March, 1927. Reprinted from Rep. Dept. of Agr., Central Provinces and Berar, for the year 1926–27, 7 pp.

The local Poona and Cawnpore varieties of chickpea, as well as the Deshi cultivar, again proved resistant to wilt (*Fusarium* sp.); red gram from Karachi and No. 28 were very susceptible.

84. DASTUR, J. F. 1935. Gram wilts in the Central Provinces. Agr. Live-Stk. India. 5:615–627.

In the Central Provinces of India, the most important diseases of chickpea are two wilts, one associated with a species of *Rhizoctonia* resembling *R. bataticola* (*Macrophomina phaseoli*) and another shown by field experiments to be physiological in nature. Although the former attacks a wide range of chickpea cultivars, only mature plants are affected; thus it causes less damage to the crop than does the latter. Its first symptom is the bronzing of the leaves on one or more of the lower branches, the color later changing to yellow and then to brown; the affected branches and leaf stalks are stiff and turned upwards, and the leaflets stand more or less vertically and are prematurely shed. The terminal parts of the tap-root and of the laterals are black or brown and shrivelled.

The physiological wilt, on the other hand, is restricted only to certain chickpea cultivars and may appear on the plants at any stage of growth. The first symptom is the drooping of the tender apical parts with a slight loss of color of the affected organs; later the plant exhibits distinct chlorosis and its apical parts and leaves hang down limply. The latter are not easily shed, and with time the wilted plant may turn brown and continue to stand thus in the field for a long time. The root system shows no external signs of rot. In a large number of cases, a species of *Fusarium* was isolated from the underground roots of a wilting plant, but all attempts to infect seedlings or plants through wounds or otherwise with this isolate invariably gave negative results.

Fairly full details are given of chickpea cultivar tests carried out at Pusa from 1927 to 1933, inclusive, in a field known to produce plants affected by physiological wilt. Nagpur 28 selection gave a high yield but was most susceptible to wilt; a strain from Cawnpore proved very resistant but its yield was poor, while one from Karachi possessed considerable resistance and compared favorably with No. 28 in yield. The results showed clearly that in one part of the field the growth of certain cultivars of chickpea was adversely affected, whereas in the other part these cultivars may be safely grown. There was also evidence that the normal cultivation operations do not serve to disseminate the disease, indicating the noninfectious nature of the wilt.

Rhizoctonia-wilted plants did not bear sclerotia, but these were found in pure cultures of the fungus; the sclerotia obtained from the strain isolated from plants of the Karachi cultivar of chickpea were much larger in size than those obtained from the strain isolated from the Cawnpore cultivar, and also differed from the latter in shape. The two strains of the fungus showed differences in growth on artificial media. Both strains failed to infect either wounded or nonwounded chickpea plants in ordinary inoculation experiments, but produced distinct signs of infection when the experimental plants in pots were exposed to high temperatures (75° to 80° C) for a few hours daily for 6 or 7 days.

85. DEL CANIZO, J. 1972. Methods of preventing 'rabia' or 'scorch' of chickpea (in Spanish). Bol. Pat. Veg. Ent. Agr. 2 (5–7):10–14.

A brief account of the destructive disease known as "rabia" or "scorch" of chickpeas, together with observations on the life-history of the causal organism (*Phyllosticta rabiei*) and directions for control. These include the use of clean seed, which may be disinfected by 5 minutes' immersion in 0.5% copper sulphate; the destruction of all diseased plants immediately when detected; and two applications of 2% Bordeaux mixture, one before and the other after flowering. The total area in chickpea in Spain is estimated to be 250,000 ha.

86. DEMETRIADES, S. D., D. G. ZACHOS, P. T. CONSTANTINOU, C. G. PANAGOPULOS, and C. D. HOLEVAS. 1958, 1959. Brief reports on the principal plant diseases observed in Greece during the years 1957, 1958 (in French). Ann. Inst. Phytopath. Benaki, N.S., 1, 6:323–329, 1958; 2, 1:3–11, 1959.

Damage to chickpea by *Ascochyta rabiei* amounted to 10 to 20 percent.

87. DE SOUSA DA CAMARA, E., A. L. B. DE OLIVEIRA, and C. G. DA LUZ. 1939. Some rusts of Portugal I (in Portuguese). Agron. lusit. 1, 4:410–434.

A critically annotated list of 40 rusts collected in Portugal from 1937 to 1939, 11 of which are enumerated in the present installment as new records for the country. Among these is *Uromyces ciceris-arietini* on chickpea.

88. DEY, S. K. 1948. Studies on the deficiency diseases like 'bronzing' and 'yellowing' of gram (*Cicer arietinum* L.) Part 1 of Assoc. I.A.R.I. thesis, Indian Agr. Res. Inst. New Delhi, India. 92 pp.

89. D'OLIVEIRA, MARIA DE L. 1946. The broad-bean mosaic and its relations with other Leguminosae (in Portuguese). Broteria, 15:90–94.

Chickpea could be artificially inoculated through sap of mosaic-affected broad-bean.

90. ECHANDI, E. 1970. Wilt of chickpeas or garbanzo beans (*Cicer arietinum*) incited by *Fusarium oxysporum*. Phytopathology 60:1539 (Abstr.).

Wilt has been recognized as the most serious disease of chickpeas in Peru. Symptoms consist of wilting and yellowing of the foliage and necrosis of the roots. Isolations from more than 250 wilted plants invariably yielded *Fusarium oxysporum*. *F. lateritium* was not isolated. Chickpeas inoculated with monoconidial isolates of *F. oxysporum* developed symptoms similar to those observed in field, and the pathogen was easily reisolated from inoculated plants. Susceptibility of plants was increased by wounding the roots. Thirty-day old chickpea plants were more susceptible to wilt than 10- to 20-day old plants. Greenhouse studies substantiate the fact that wilt is more severe in light sandy soils than on heavy clay soils. Chickpea varieties Espanol and Gigante were more resistant to wilt than the widely used local variety Criollo.

91. ERSHAD, D. 1971. Contribution on the knowledge of *Phytophthora* species in Iran and their phytopathological significance (in German). Mitt. Biol. Bund. Anst. Ld. u. Forstw. 140, 84 pp.

Phytophthora drechsleri is reported from Iran for the first time.

92. ERWIN, D. C. 1957. Fusarium and Verticillium wilt diseases of *Cicer arietinum*. Phytopathology 47:10 (Abstr.).

A wilt disease of *Cicer arietinum* in California, characterized by leaf yellowing and xylem necrosis, is attributed to a *Fusarium* sp. Certain selections were resistant, while cowpea and lucerne were not attacked. *Verticillium albo-atrum* was also isolated from *C. arietinum* and induced a wilt in it.

93. ERWIN, D. C., and B. W. KENNEDY. 1957. Studies on Phytophthora root rot of Alfalfa. Phytopathology 47:520 (Abstr.).

In greenhouse experiments in California, root rot of lucerne seedlings, due to *P. cryptogea*, was at a maximum at soil temperatures of 22 and 27° C, very little occurred at 17°, and none at 32°. *Cicer arietinum* and *Sesbania* sp. also proved susceptible. Zoospores obtained by incubating infected lucerne stems in aerated 1 / 2-strength Hoagland's solution for 15 to 30 hr were the best inoculum. The cultivar Lahontan showed some tolerance.

94. ERWIN, D. C. 1958. *Fusarium lateritium* f. *ciceri*, incitant of Fusarium wilt of *Cicer arietinum*. Phytopathology 48:498–501.

This wilt has been present in California for several years. Leaves of affected plants turn grey-green, then dull yellow, and wilt; the xylem and pith become much darkened. On the other hand, leaves of plants affected by a virus-induced yellows disease, bean yellow mosaic, and possibly other viruses become bright yellow and discoloration of the stem tissues occurs initially in the phloem. Wilt induced by *Verticillium albo-atrum* causes a lighter stem-tissue discoloration. The fungus isolated and shown to cause the Fusarium wilt was *F. lateritium* (*Gibberella lateritia*), considered to be the same as Watts Padwick's *F. orthoceras* f. *ciceri*, to which this wilt was attributed in India, and as the pathogen did not affect pigeonpea or *Crotalaria juncea* it is regarded as a new form. A California selection of chickpea showed promising resistance to the disease.

95. ERWIN, D. C. 1958. Verticillium wilt of *Cicer arietinum* in southern California. Plant Dis. Reptr. 42:1111.

This wilt, caused by *V. albo-atrum*, has been seen occasionally in Los Angeles county since 1954. Infection developed in plants inoculated by dipping the roots in a spore suspension, but did not develop in plants grown in infested soil, indicating that some injury may be necessary for the natural wilt to occur.

96. ERWIN, D. C., and W. C. SNYDER. 1958. Yellowing of Garbanzo Beans. Calif. Agr. 12:6, 16.

A note comparing patch incidence and symptoms of soil-borne Fusarium wilt of chickpea [*F. lateritium* (*Gibberella lateritia*) f. *ciceri*] with the scattered incidence of aphid-transmitted virus yellowing, in the causation of which the bean yellow mosaic virus is stated to be a dominant factor, though other aphid-transmitted viruses, including pea enation (mosaic) and alfalfa (lucerne) mosaic also infect this host in California. Fusarium wilt can be spread in pieces of root or stem, and the surface of the seed may become infected during threshing. The wilt is recognized by the discoloration of the stele, in contrast to the discoloration under the bark in virus disease.

97. ESER, D. 1976. Heritability of some important plant characters, their relationships with plant yield and inheritance of Ascochyta blight resistance in chickpea (*Cicer arietinum* L.) (in Turkish). Ankara Universitesi Ziraat Fakultesi Yayinlari 620, 40 pp.

A local line with Cod. no. 9276, highly susceptible to *Ascochyta*, was crossed with a resistant line Cod. no. 72–012 (from Israel). The parents and F_1 and F_2 progenies were tested for the study of inheritance. One week before the flowering, the plants were inoculated with *Ascochyta rabiei* spores. The F_1 plants showed resistant reaction. Chi-square analysis of the F_2 population revealed the simple monogenic Mendelian segregation ratio—i.e., three resistant to one susceptible.

98. FAWCETT, G. L. 1941. Department of Botany and Phytopathology. Annual Report for the year 1940 (in Spanish). Rev. Industr. Agr. Tucuman 31:47–50.

A species of *Pythium* has been isolated from decayed roots of chickpeas in the Trancas district (Argentina) where gaps in the stand due to an as yet unexplained disease occur annually in the same spots. A *Rhizoctonia* is responsible for similar injury to this crop under humid conditions.

99. FAWCETT, G. L. 1943. Department of Botany and Phytopathology. Annual Report for the year 1942. Rev. Industr. Agr. Tucuman, 33:63–65.

As in previous years, chickpeas were affected by a malady involving decay of tap-root tips and desiccation of the plants without producing seed. In 1942, the normal planting date was postponed on account of the severe winter weather, with the result that the crop was attacked while still green and in full flower. A species of *Pythium* was found in the soil underlying the diseased patches, but is not thought to cause the disease. The true source of the trouble is likely to be either in the nature of the soil or in the water relations of the sub-soil.

100. FREZZI, M. J. 1950. The species of *Phytophthora* in Argentina (in Spanish). Rev. Invest. Agr. B. Aires, 4:47–133.

P. citrophthora and *P. drechsleri* are reported on chickpea.

101. FREZZI, M. J. 1956. Phytopathogenic species of *Pythium* identified in the Argentine Republic (in Spanish). Rev. Invest. Agr., B. Aires 10:113–241.

Pythium debaryanum was isolated from root rot of chickpea.

102. GALLEGOS, H. M. L. 1963. Chickpea rust: a new disease in Mexico (in Spanish). Agricultura Tecnica Mex. 2:71.

Uromyces ciceris-arietini is newly recorded on chickpea in the Western Hemisphere, probably as an introduction from Europe.

103. GALLEGOS, H. M. L., E. L. REYNOSO, and J. ORTEGA. 1965. Observations on chickpea rust in Central Mexico. Phytopathology 55:125.

Chickpea rust was observed in Mexico for the first time in the state of San Luis Potosi in 1961. The disease, caused by *Uromyces ciceris-arietini*, spread very quickly in Central Mexico and by 1963 was found in several states. Observed losses were variable, but in many cases were complete. At present the disease is the most important limiting factor in chickpea production. Observations made under greenhouse and field conditions on 188 varieties in 1964 showed high susceptibility in 36 of the "Garbanzo" type and 162 of the "porquero" type. Several dosages of Parzate, sulfur, ferbam, and other fungicides were tested for effectiveness on a "porquero" type by applying them before the rust appeared. Two years' results indicate that no satisfactory control was obtained with any fungicide.

104. GEORGHIOU, G. P., and C. PAPODOPOULOS. 1957. A second list of Cyprus fungi. Tech. Bull. Dep. Agr. Cyprus 5, 38 pp. (Mimeographed).

This bulletin contains 49 new records for Cyprus made during 1954–57, bringing the total number of fungi recorded there to 420. The list includes *Ascochyta rabiei* on chickpea.

105. GOBELEZ, M. 1956. Research work on the varieties and areas of spread of bacterial and parasitic diseases affecting and contaminating the seeds of cultivated plants grown in certain provinces of Central Anatolia as well as the approximate degree of damage caused by such diseases (in Turkish). Zir. Fak. Yayinl., 107, 62, 131 pp.

In studies carried out in 1954 and 1955 the author detected approximately 50 seed-borne diseases of cultivated plants, including *Mycosphaerella rabiei* on chickpea, in Central Turkey.

106. GONZALEZ FRAGOSO, R. 1921. New or little-known Sphaeropsidales of the Spanish fungous flora (in Spanish). Asociacion Espanola para el Progreso de las Ciencias. Congreso de Oporto, VI. Ciencias Naturales: 35–57.

An annotated list of new or little-known Sphaeropsidales in Spain. *Phyllosticta rabiei* causes anthracnose of chickpea, a disease usually attributed to *Ascochyta pisi*. Previous Spanish records include this disease with the anthracnose of peas and other leguminous plants as all caused by the last-named fungus. While the fungus described by Trotter is usually responsible for the disease on chickpea, the author thinks it not possible that *A. pisi* may occasionally attack this host.

107. GORLENKO, M. V., and Mme L. N. BUSHKOVA. 1958. Perfect state of the causal agent of ascochytosis of chickpea (in Russian). Plant Prot., Moscow 3:60.

In laboratory and greenhouse studies at Moscow University, *Mycosphaerella rabiei* is pathogenic only on chickpea. Ascocarps develop on plant remains in the field.

108. GREWAL, J. S. 1969. Important fungal disease of *Cicer arietinum* in India. Pulse Improvement Project Seminar Report held at Karaj Agricultural College, University of Tehran & USDA, January 7–9, 1969:35–40.

A brief review of the work done by the author and his colleagues on chickpea blight (*Ascochyta rabiei*) and wilt. Wilt causes damage in two phases. First phase is prominent 2 to 4 weeks after sowing. No pathogen could be consistently isolated. The second phase appears in February and March when plants are in flowering and pod forming stages. *Operculella padwickii* was found to cause foot rot or wilting symptoms in February. Wilted plants in March yielded both *O. padwickii* and *Fusarium* sp. The former is pathogenic, but the latter is erratically pathogenic. The author suggests that the wilt is probably due to an interaction between high temperature, moisture stress, and fungal pathogens.

A mechanically transmissible virus was found affecting chickpea at New Delhi in Mar 1968, causing severe necrosis of shoots. Plants killed by virus could easily be confused with wilt.

109. GREWAL, J. S., and S. VIR. 1974. Varietal resistance of gram to Ascochyta blight. Indian Phytopath. 27:643–645.

Several lines / cultivars were tested through artificial inoculations in field for 2 years. A five-point rating scale was developed. Selection P–1528–1–1 from Morocco was found to be immune and I–13 (12–074–06625) from Israel was found to be resistant. All others were found to be moderately susceptible to highly susceptible.

110. GREWAL, J. S., M. PAL, and D. D. KULSHRESTHA. 1974. A new record of wilt of gram caused by *Fusarium solani*. Curr. Sci. 43:767.

Fusarium solani was found responsible for causing wilt in some states of northern India.

111. GREWAL, J. S., M. PAL, and D. D. KULSHRESTHA. 1974. Fungi associated with gram wilt. Indian J. Genet. and Plant Breeding 34:242–246.

Isolations from wilted gram plants were made monthly throughout the crop season. *Fusarium solani* was obtained from 24.7 percent, *F. oxysporum* f. *ciceri* from 15.5 percent, *Rhizoctonia solani*, *R. bataticola*, *Operculella padwickii* and *F. moniliforme* from 8.5, 8.3, 6.2 and 1.6 percent of the wilted plants, respectively.

In another set of isolations made from 12 villages of Delhi and Haryana as well as from gram crops at I.A.R.I., New Delhi; H.A.U., Hissar; P.A.U., Ludhiana; *F. solani* was isolated in more frequency than *F. oxysporum* f. *ciceri*. *Fusarium solani* was a dominant wilt pathogen (48.0%) at Ludhiana. *R. bataticola* and *O. padwickii* were more prominent in state of Haryana than Delhi and P.A.U., Ludhiana. *R. solani* was responsible for early wilt at Delhi.

In pathogenicity tests *F. solani*, *F. oxysporum* f. *ciceri*, and *R. solani* were found to be virulent pathogens which caused 82 to 100 percent mortality of inoculated plants within 20 days. *Operculella padwickii* took 6 to 8 weeks to kill 40 percent of the plants, indicating that it is a slow-growing weak pathogen. Isolates of *R. bataticola* and *F. moniliforme* were not found to be pathogenic.

112. GREWAL, J. S. 1975. Asocochyta blight of Bengal gram. *In* Advances in Mycology and Plant Pathology, Publ. Prof. R. N. Tandon's Birthday Celebration Committee, Indian Phytopath. Soc., New Delhi, pp. 161–167.

Brief review of various aspects of the disease.

113. GUPTA, P. K. S. 1974. Diseases of major pulse crops in India. PANS 20 (4):409–415.

The main pathogens of chickpea are *Fusarium oxysporum* f. sp. *ciceri*, *Mycosphaerella pinodes*, and *Uromyces ciceris-arietini*.

114. GUPTA, S. C., and R. K. KOHLI. 1967. Production of cellulolytic enzymes by *Fusarium orthoceras* App. and Wr. var. *ciceri* Padwick. Proc. Natn. Acad. Sci. India. B. 37:264–268.

F. oxysporum var. *ciceri*, causing wilt of chickpea, secreted cellulase and C_1 enzyme on a synthetic medium containing 1% glucose, 0.1% KH_2PO_4, and 0.05% $MgSO_4$ when incubated for 4 days at 25°C. It is suggested that these enzymes may play an important role in pathogenesis.

115. HAFIZ, A. 1952. Basis of resistance in gram to Mycosphaerella blight. Phytopathology 42:422–424.

Morphological and physiological studies at the Punjab Agricultural College, Lyallpur, Pakistan, on types of chickpea susceptible and resistant to *Mycosphaerella rabiei* indicated that the greater number of hairs on the resistant F8 and F10, as compared with the susceptible P7 and P15, induces more extensive secretions of malic acid in the later growth stages and this in turn is detrimental to spore germination and germ-tube development. It was observed, moreover, that the fungus requires a longer period for the penetration of more resistant types, 96 hours being necessary to accomplish 100 percent infection of F8 and F10 as against 24 hours for P7. In the early stages of growth when malic acid production is low, however, there is no difference between the two types in reaction to *M. rabiei*, escape from infection at this period being attributable merely to lack of inoculum and the prevailing low temperature and low humidity, both unfavorable to the pathogen.

116. HAFIZ, A., and M. ASHRAF. 1953. Studies on the inheritance of resistance to Mycosphaerella blight in gram. Phytopathology 43:580–581.

At the Punjab Agricultural College, Lyallpur, Pakistan, crosses were made with two French types of chickpea (F8 and F10) resistant to blight (*Mycosphaerella rabiei*) and two Punjab

susceptibles, P7 and C7. All F_1 progeny of these crosses and those of the two resistant parents were resistant; two susceptible types yielded susceptible hybrids only. Segregation among F_2 and F_3 offspring indicated that inheritance is monogenic.

117. HALFON-MEIRI, A. 1970. Infection of chickpea seeds by *Ascochyta rabiei* in Israel. Plant Dis. Reptr. 54:442–445.

Seed infestation of chickpea pods showing *A. lesions* was 50 to 80 percent, whereas all seeds in symptomless pods were healthy. Pod infestation affected seed formation, size, and germination. Where infested seed had lesions mycelium occurred under the seed coat, sometimes penetrating the cotyledon. Growth rate of month-old seedlings from infested seed was lower than that of those from healthy seed.

118. HAWARE, M. P., and Y. L. NENE, 1976. Some uncommon but potentially serious diseases of chickpea. Tropical Grain Legume Bull. No. 5:26–30.

Incidence of Neocosmospora root rot (*Neocosmospora vasinfecta*), white seed and root rot (a sterile fungus), and Alternaria blight (*Alternaria* state of *Pleospora infectoria*) is reported. The diseases occur under atypical environments but they have potential to cause severe damage under favorable weather conditions.

119. HUSAIN, S. S., and M. A. AHMAD. 1971. Studies on stored food grain fungi. Part IV. Fungi from pulses. Pakistan J. Sci. & Industr. Res. 14:507–511.

Thirty-six species were isolated from various legumes, including chickpea. Of 12 *Aspergillus* spp. (60% of the total), *A. flavus* (24%) predominated.

120. HUTTRON, M. M. E., and T. A. CAMPOS. 1966. Tests for the resistance of chickpea lines to root diseases (in Spanish). Agrociencia 1:67–76.

Several fungi causing root rot were isolated from roots of chickpea in various regions of Mexico. When healthy seeds of 15 chickpea lines resistant to root rot were inoculated with each of the isolates, seedlings of all the lines showed resistance to *Sclerotinia* sp. but were highly susceptible to *Rhizoctonia* sp. Reactions to *Fusarium* spp. and two *Verticillium* spp. varied considerably.

121. IBRAGIMOV, G. R., S. AKHMEDOV, and S. GARADAGI. 1966. New preparations for the control of ascochytosis and Fusarium wilt of chickpea and broad-bean (Azer. summ.). Trudy azerb. nauchno-issled Inst. Zemledei 13:130–135.

Tsyzol (?cysol), cuproneb, mercuran, and fentiurom (alone and with) molybdate proved highly effective against ascochytosis (*Ascochyta fabae*) of broad-bean. Of seven preparations tested, benzocide gave best growth and increased yield by 32.4 percent. Fentiurom alone and + molybdate were most effective against ascochytosis (*A. rabiei*) and dipropylfumacide and fungifos against Fusarium wilt of chickpea.

122. IBRAGIMOV, G. R., S. A. AKHMEDOV, and S. M. GARADAGI. 1966. Use of phenthiuram and phenthiuram molybdate against diseases of Fodder Beans and *Cicer arietinum* under Azerbaidzhani conditions. Khimiya sel'. Khoz. 4:23–24.

In field tests against *Fusarium* spp. and *Ascochyta rabiei* on chickpea and *A. fabae* on broad-beans, seed treatment with phenthiuram (40% thiram, 10% Cu trichlorphenolate, and 20% y-BHC) and phenthiuram molybdate at 3 to 4 g/kg controlled *Ascochyta* infection on both hosts. *Fusarium* was not controlled, but the growth of chickpea was stimulated and yield increased.

123. JACOBS, S. E., and U. MOHANTY. 1951. Studies in bacteriosis. XXVII. Factors influencing infection by *Corynebacterium fascians* (Tilford) Dowson. Ann. Appl. Biol. 38:237–245.

The pathogenicity of 22 strains of *Corynebacterium fascians* to Punjab 7, a pure line of chickpea, and two sweet peas inoculated without wounding by bacterial suspensions in sterile water was tested in the Bacteriological Laboratory, Imperial College of Science and Technology, London. Chickpea was shown to be a new host for the bacterium.

124. JADHAV, M. R. 1966. Studies on gram wilt caused by *Operculella padwickii* Kheswalla. M.Sc. (Ag.) thesis, J. N. Krishi Vishwa Vidyalaya, Jabalpur, India.

125. JAIN, H. K., P. N. BAHL, and D. B. RAJU. 1973. Wilt problem and some possible experimental approaches. Symposium on wilt problem and breeding for wilt resistance in Bengal gram. September 1973, Indian Agric. Res. Inst., New Delhi, India. p. 19. (Abstr.).

A large number of factors are thought to be involved in causing or in aggravating the wilt disease of chickpea. Temperatures during the ripening period, sowing date, depth of sowing, density of plant stands, soil texture, moisture stress, and several other factors seem to contribute to the wilt condition. Critical evidence in relation to the contribution made by each of these factors is lacking, and interactions between these factors is not known. A factorial experiment to obtain information on these factors and their interactions is suggested.

Failure to breed wilt-resistant varieties in chickpea is to a large extent due to the fact that the pathogen response for this disease has not been clearly identified. Cooperation between plant breeders and pathologists has been suggested.

126. JAUCH, C. 1947. Observations on natural and artificial infections with '*Pellicularia filamentosa*' (= *Corticium solani*) (in Spanish). Publ. Misc. Minist. Agric., B. Aires 3 (24):1–7.

In June 1944, 2- to 3-month old broad-bean plants at a regional plant quarantine station in Argentina presented large necrotic lesions along the stems and at their bases; the plants succumbed within a few weeks. Microscopic examination revealed invasion of all the underlying cells by a copious mycelium consisting of hyaline, latter ochraceous-buff, septate hyphae, which was identified as that of *Pellicularia filamentosa (Corticium solani)*. In April 1945, the same fungus developed in eight isolations from chickpea seedlings showing dark elongated and slightly sunken basal lesions. Two others yielded *Fusarium* sp.

Basidia with sterigmata (6 to 13 μ in diameter) and basidiospores (8 to 13 by 4 to 7 μ) arose from the mycelium covering the soil in pot inoculation experiments with isolates of the fungus from the two above-mentioned hosts, pine, and *Iberis*.

The production of the fructifications was expedited under humid conditions at a temperature range of 20° to 25° C. Their formation on the soil itself, besides explaining the wide diffusion of the pathogen, emphasizes the need for stringent precautions to obviate confusion between natural and artificial infection in inoculation experiments.

127. JOSHI, M. M., and R. S. SINGH. 1969. A Botrytis gray mold of gram. Indian Phytopath. 22:125–128.

B. cinerea causing a serious disease of chickpea was first observed in India in 1967–68. It destroyed the entire crop of var. G-24, but T-730 (Kabuli) showed least disease. Dark brown lesions 10 to 30 mm long appeared on the stem, branches, leaves, and inflorescence. Sporodochia were produced on thick and woody stems. Morphological and cultural characters of the pathogen are given. Pathogenicity tests on gram and pea were positive. The connection between *B. cinerea* and Sclerotinia blight occurring in the same fields was established, but the specific identification of the *Sclerotinia* could not be obtained, though *S. sclerotiorum* on chickpea has been reported in India.

128. KAISER, S. A. K. M., and P. K. SEN GUPTA. 1975. Growth response of three formae speciales of *Fusarium oxysporum* to their host and nonhost plants. Folia Microbiologica 20:168–170.

Fusarium oxysporum f. sp. *ciceri* is one of the three f. sp. studied. The growth of the fungus was more towards chickpea roots than towards roots of nonhost plants.

129. KAISER, S. A. K. M., and P. K. SEN GUPTA. 1975. A pathogenic strain of *Trichoderma harzianum* causing foot rot of *Cicer arietinum*. Phytopath. Z. 83:185–187.

The strain was isolated from diseased plants at the Univ. Farm, Kalyani, India. Typical foot-rot symptoms appeared in chickpea seedlings 6 to 8 days after soil inoculation.

130. KAISER, W. J., D. DANESH, M. OKHOVAT, and H. MOSSAHEBI. 1968. Disease of pulse crops (edible legumes) in Iran. Plant Dis. Reptr. 52:687–691.

Disease problems of different pulse crops in Iran have been briefly reviewed. Natural infection of chickpea by alfalfa mosaic virus, bean yellow mosaic virus, and cucumber mosaic virus has been reported. Fungal diseases reported are (i) root rots caused by *Rhizoctonia solani, Macrophomina phaseoli, Pythium* sp., *Fusarium* spp., (ii) blight by *Ascochyta rabiei,* (iii) rust (*Uromyces* sp.), and (iv) powdery mildew (*Erysiphe* sp.).

131. KAISER, W. J., D. DANESH, M. OKHOVAT, and H. MOSSAHEBI. 1968. Regional pulse improvement project. Diseases of pulse crops (edible legumes) occurring in Iran. Iran J. Pl. Path. 4:2–6.

On chickpea, alfalfa mosaic virus occurred. *Ascochyta rabiei* was found in some areas, though not of importance.

132. KAISER, W. J., and F. ESKANDARI. 1970. Studies with bean yellow mosaic virus in Iran. Iran J. Pl. Path. 6:26–27.

This virus is one of the most important and widespread on legumes in Iran, affecting chickpea and several other legumes. The virus is spread by aphids and is seed-borne in broad-bean. Electron microscopy revealed flexuous rods, 750 m μ.

133. KAISER, W. J., and D. DANESH. 1971. Biology of four viruses affecting *Cicer arietinum* in Iran. Phytopathology 61:372–375.

Alfalfa mosaic, bean yellow mosaic, cucumber mosaic, and pea leaf roll (PLRV) viruses, all isolated from chickpea in Iran, over-wintered in annual and perennial forage legumes, weeds, and cultivated crops. The main aphid vectors were *Aphis craccivora, Acyrthosiphon pisum,* and *A. sesbaniae,* and all except PLRV were stylet-borne while PLRV was transmitted in a circulative manner. Incidence of viruses in chickpea was 3 to 13 percent and usually related to the proximity of reservoir hosts. Infection, particularly before flowering, reduced yield and increased plant mortality. PLRV had the most severe effects. Seeds from diseased plants were often deformed and had poor germination but none of the viruses was seed-borne in this host.

134. KAISER, W. J., and D. DANESH. 1971. Etiology of virus-induced wilt of *Cicer arietinum*. Phytopathology 61:453–457.

Wilt symptoms in chickpea in Iran are induced by alfalfa mosaic, bean yellow mosaic, cucumber mosaic, and pea leaf roll viruses. Other virus-induced symptoms included stunting, yellowing, secondary shoot formation, leaf deformation, dwarfing, and phloem discoloration.

135. KAISER, W. J. 1972. Occurrence of three fungal diseases of chickpea in Iran. FAO Plant Prot. Bull. 20:74–78.

The occurrence of two foliar diseases (*Ascochyta rabiei* and *Stemphylium sarciniforme*), both becoming epidemic, and a stem and crown blight caused by *Sclerotinia sclerotiorum* affecting scattered plants in chickpea plots used in yield trials in southwest Iran is reported. The last two diseases have not previously been reported from Iran. The black-seeded accessions in the trials were generally more resistant to *A. rabiei* than the white-seeded types, and one from Israel proved highly resistant. Both foliar pathogens are seed-borne in chickpea. *A. rabiei* was isolated from seed which had been stored for more than 117 weeks at Safiabad where summer temperatures exceeded 45° C.

136. KAISER, W. J. 1972. Diseases of food legumes caused by pea leaf roll virus in Iran. FAO Plant Prot. Bull. 20:127–132.

Pea leaf roll virus infected bean (*Phaseolus vulgaris*), broadbean, chickpea, cowpea, lentil, and pea. Transmission, symptoms, distribution of the virus, effects on yield, effect of planting date on PLRV incidence, and alternative hosts are discussed. Control measures, including spraying against the aphid vectors and selection and breeding for resistance, are considered.

137. KAISER, W. J. 1973. Factors affecting growth, sporulation, pathogenicity, and survival of *Ascochyta rabiei*. Mycologia 65:444–457.

A. rabiei isolates from diseased chickpea from India, Iran, Turkey, and Pakistan varied greatly in growth rate, sporulation, and colony growth usually on 8% chickpea seed meal agar and oatmeal agar. Optimum temperature for growth and sporulation was 15 to 20° C and the upper limit for growth 30°. Continuous light increased mycelial growth rates and spore production, whereas zonation occurred in alternating dark and light periods. Near-UV and blue light increased growth and sporulation. The fungus also infected *Phaseolus vulgaris* and cowpea on inoculation but was highly pathogenic only to chickpea.

Of the many chickpea lines tested, only one black-seeded type was highly resistant to most isolates of the pathogen. Pycnidia with viable spores formed on dry stem pieces at 10 to 30° (opt. 20°). Mature pycnidia formed at 20° in 46 hr in continuous light, 50 hr in alternating light and dark, and 68 hr in continuous dark. The fungus survived over 2 yr in naturally infected tissue at 10 to 35°, RH 0 to 3 percent, and on the soil surface. It lost viability rapidly at RH 65 to 100 percent and at soil depths of 10 to 40 cm.

138. KAISER, W. J., M. OKHOVAT, and G. H. MOSSAHEBI. 1973. Effect of seed-treatment fungicides on control of *Ascochyta rabiei* in chickpea seed infected with the pathogen. Plant Dis. Reptr. 57:742–746.

Incidence of the disease in chickpea seedlings was greatly reduced and emergence markedly increased when infected seed was treated with certain chemicals, especially the systemic benzimidazoles benomyl and TBZ. Treatment of healthy seed with different fungicides before planting did not protect the foliage of seedlings against infection when the plants were inoculated 2 to 3 weeks after emergence. Adverse effects were not noted on germination, growth, flowering, or pod set of plants whose seeds had been treated with fungicides.

139. KAISER, W. J., and G. H. MOSSAHEBI. 1975. Studies with cowpea aphid-borne mosaic virus and its effect on cowpea in Iran. FAO Plant Prot. Bull. 23 (2):33–39.

When inoculated artificially, chickpea (Gazvin) was found to be a symptomless host of the virus.

140. KANDASWAMY, T. K., and C. NATARAJAN. 1974. A note on phyllody diseases on Bengal gram (*Cicer arietinum* L.). Madras Agr. J. 61:1019–1020.

During the year 1972, 6 percent of chickpea plants in the University Experimental Farm exhibited symptoms of phyllody of flowers. Plants affected by the disease were distinguished in the field by paleness of the foliage, bunchy appearance, and stunted growth. Leaflets were one-third the size of healthy leaflets. Main branches in infected plants were fewer and were accompanied by proliferation (by three-fold) of auxillary shoots. Floral parts were reduced to green phylloid structures and petals were malformed. Stamens were free and not diadelphous. The ovary, instead of being concealed within the keel petals, was exposed.

Orosius albicinctus Distant, the vector of *Sesamum* phyllody disease, was observed to be active in plots of chickpea a month before the appearance of the symptoms. Neighboring field plots, where sesamum and sunnhemp were grown till October-November, were infected up to 10 percent with phyllody disease.

141. KARAHAN, O. 1968. Investigations on methods to control *A. rabiei* on *Cicer arietinum* (in Turkish). Bitki Koruma Bult. 8:77–109.

In laboratory, greenhouse, and field tests in Turkey the best results against *A. rabiei* were obtained by treatment with Arasan-75 at 300 g/100 kg seed. Removal of infected plants and drying harvested plants for a week in the sun are recommended.

142. KEEN, N. T. 1975. The isolation of phytoalexins from germinating seeds of *Cicer arietinum, Vigna sinensis, Arachis hypogea,* and other plants. Phytopathology 65:91–92.

Germinating seeds of chickpea, cowpea, groundnut, and several other plants challenged with the native microflora produced the same phytoalexins as other plant tissues. When moderate amounts of incubated seeds were processed, quantities of phytoalexins (30 to 100 mg) could be isolated.

143. KENNETH, R., and Y. ESHEL. 1971. Appearance of downy mildew in chickpea (in Hebrew). Hassadesh 51:1397–1398.

During 1970–71 season, the authors discovered a downy mildew on chickpea in southern part of Israel. The fungus was identified as a species of *Peronospora*. Symptoms were partial change in color of infected leaflets and appearance of thick dark-purplish down on undersides of leaflets and pods. The down consisted of dichotomous conidiophores and light-brown ovoid conidia (27 to 38 × 19 to 24 μ). The conidia germinated directly. Infected leaflets dropped off shortly after being infected. Fallen leaflets often contained brown globose resting spores, 32 to 41 μ in diameter. The outer wall of oospores shows tubercles (verrucose).

144. KHACHATRYAN, M. S. 1961. Seed transmission of ascochytosis infection in chickpea and the effectiveness of treatment (in Russian). Sbor. nauch. Trud. nauch. issled. Inst. Zemledel. Armyan, S. S. R. 2:147–155.

Seed transmission is one of the basic ways in which *Ascochyta rabiei* of chickpea is spread, the disease being most serious when pods are infected at the start of formation. The most effective seed treatments were thiram and 50% T.S.B. at 5 and 10 kg/ton.

145. KHACHATRYAN, M. S. 1962. Some problems of the biology and dynamics of development of ascochytosis of chickpea in the Armenian S.S.R. (in Russian). Izv. Akad. Nauk. Armyan, S.S.R. biol. Sci. 15:23–30.

Studies in 1954–55 at the Kirovakan State Varietal Plot, Inst. Wine Making, Viticulture and Fruit Growing, showed that *Ascochyta rabiei,* one of the most serious diseases of chickpea in the Armenian S.S.R., overwinters and may reproduce on the remains of infected plants on the soil surface. Inoculation of plants with a spore suspension gave positive results at all development stages. Symptoms appeared as early as 3 to 5 days after inoculation. In Kirovakan conditions there were three generations of *A. rabiei* during 12 Jul to 3 Sep; under opt. conditions there can be more.

The pathogen is strictly specialized to chickpea. The ascus state was not observed. Appearance and spread of the disease was closely connected with climatic factors and weather, requiring over 60 percent R.H., 350 to 400 mm rainfall in the summer months, and average daily temperature of not less than 15°C.

146. KHAN, B. M. 1970. Effect of gamma rays irradiation on yield and the incidence of blight disease of gram. Agriculture Pakistan 21:43–46.

Seeds of two improved lines (T.S.S. and LII) and cultivar C727 of chickpea were irradiated (5–25 kr) and their progeny raised to the F_3 generation. Plants in the treated progeny lines differed greatly in morphological characters and were larger than the nonirradiated ones. Higher doses of irradiation (15 kr and above) reduced the percentage emergence, but induced resistance to *Ascochyta rabiei* and increased the yield of healthy seeds.

147. KHAN, S. A., and M. KAMAL. 1962. Some additional hosts of *Leveillula taurica* (Lev.) Arnaud from Pakistan. Pakistan J. Sci. Res. 5:41.

Ten naturally infected hosts reported for the first time from Agric. Res. Inst., Tandojam, include chickpea.

148. KHARE, M. N., K. G. NEMA, and L. S. KUSHWAHA. 1973. Control of wilt of Bengal gram through fungi. Symposium on wilt problem and breeding for wilt resistance in Bengal gram. September 1973 at Indian Agric. Res. Inst., New Delhi, India. pp. 11–12 (Abstr.).

The best method of control is through the use of resistant cultivars, but so far none has been found to be resistant. Late sowing resulted in minimum wilting. Of several fungicides, Benlate and thiram proved better; wilting was minimal, yield highest, and adverse effect on nodulation nil. Soaking of seeds for 5 minutes in 0.1% Ceresan wet followed by treatment with 0.2% Thiram and 0.2% PCNB (Brassicol 20%) by weight checked wilt to a considerable extent.

149. KHATRI, H. L., and L. SINGH. 1974. Studies on a mosaic disease of cowpea. J. Res., Punjab Agr. Univ. 11:289–294.

Chickpea was not infected by the virus.

150. KHESWALLA, K. F. 1941. Foot rot of gram (*Cicer arietinum* L.) caused by *Operculella padwickii* nov. gen. nov. sp. Indian J. Agr. Sci. 11:316–318.

Wilted chickpea plants from Karnal in the Punjab in 1938–39

and others from the Imperial Agricultural Research Institute, New Delhi, (where the writer's studies were conducted) in 1939–40 yielded a very unusual fungus belonging to the Sphropsidales and designated *Operculella padwickii* n.g., n. sp. A total of 85 isolates of this fungus were obtained from eight of nine cultivars of the host, as compared with 111 of *Fusarium*.

The organism, grown in pure culture on oatmeal and potato dextrose agar, is characterized by unilocular, discoid to subglobose, erumpent, carbonaceious pycnidia, 270 to 810 μ in diameter, opening with an apical pore or by means of a hinged lid. Conidiophores were of two types, the shorter unbranched, averaging 83 μ in length, forming a compact layer over the entire inner pycnidial surface, and bearing spores terminally; the longer sparsely branched, sometimes septate, and producing spores on minute sterigmata. Spores are hyaline (yellowish-white in the mass), irregular in shape, continuous, and 7.4 to 16.6 by 5.5 to 11.1 μ.

151. KHIL'KO, V. G. 1974. Study on the resistance of chickpea to ascochytosis (in Russian). Genetike i Selektsii 53 (3):132–136.

None of the cultivars of chickpea tested was immune to *Ascochyta rabiei*. Samples from Bulgaria (k-1459 and -1469), Moldavia (k-1488), and the Khar'kov district (k-1502) were relatively resistant.

152. KOVACHEVSKI, I. C. 1936. The blight of chickpea, *Mycosphaerella rabiei* n. sp. (in Russian). Issued by Min. Agric. Nat. Domains, Sofia, 80 pp.

A detailed and fully tabulated account of the author's laboratory and field studies of chickpea blight (*Ascochyta rabiei*) which is stated to be of considerable economic importance in southern Bulgaria, where it usually accounts for 20 to 50 per cent of the crop, and occasionally involves the total failure of certain chickpea fields. In a detailed morphological description of the pycnidial stage (for which the generic name *Ascochyta* is preferred to *Phyllosticta*), the conidia are stated to be rarely (under 1%) septate, and to measure 6 to 16 by 3.4 to 5.6 μ on the host and 4.8 to 14 by 3.2 to 5.2 μ on artificial media. Perithecia of the fungus (the genetic connection of which with the pycnidial stage was demonstrated both in pure culture and by inoculation experiments) were found exclusively on chickpea refuse, especially the pods, that had overwintered in the field. They are dark-brown or black, globose or applanate, with a hardly perceptible beak and ostiole, 76 to 152 μ high, and 120 to 250 μ wide at their broadest portion. The asci are cylindrical-clavate, more or less curved, pedicellate, and 48 to 70 by 9 to 13.7 μ in diameter. The ascospores (eight to the ascus) are monostichous, rarely distichous, ovoid, divided into two very unequal cells, strongly constricted at the septum, and measure 12.5 to 19 by 6.7 to 7.6 μ. The name *Mycosphaerella rabiei* is suggested for the perithecial form (but no Latin diagnosis is given).

Attempts to control the disease by hot water or chemical seed disinfection were unsuccessful, but three or four sprayings of the growing plants with 1% Bordeaux mixture or preferably with 1 in 40 lime-sulphur considerably reduced the severity of the disease; it is believed, however, that the most effective control is only obtainable by the use of healthy seed produced in isolated farms protected from outside infection.

153. KOVACHEVSKY, I. C. 1936. Parasitic fungi new for Bulgaria. Fourth contribution (in Russian). Trav. Soc. Bulg. Sci. Nat., 27:13–24.

An annotated list of 19 plant parasitic bacteria and fungi including *Mycosphaerella rabiei* on chickpea, all recorded for the first time from Bulgaria during the last few years.

154. KOVACHEVSKI, I. C. 1965. Cucumber mosaic virus disease in Bulgaria (In Russian). (Abstr.) Bulg. scient. Lit. 10 (3):739.

The disease was found on 91 species belonging to 22 families. In chickpea the virus produced necrosis.

155. KRAFT, J. M. 1969. Chickpea, a new host of *Fusarium solani* f. sp. *pisi*. Plant Dis. Reptr. 53:110–111.

The fungus is newly recorded on *Cicer arietinum*, seeds of which were inoculated with spore suspensions. Five isolates tested caused slightly more root rot of pea than of chickpea.

156. KRANZ, J. 1962. Plant diseases in Cyrenaica. FAO Plant Prot. Bull. 10:121–125.

Two diseases of chickpea have been reported; the rust caused by *Uromyces ciceris-arietini* and wilt / root rot caused by *Fusarium oxysporum*.

157. KRAUSE, A. W. 1930. Investigations on the influence of nutrition, illumination, and temperature on the perithecial production of some Hypocreacae. Contribution to the cultural technique of some parasitic and saprophytic fungi (in German). Zeitschr. fur Parasitenkunde, Ab. F. 2 (4):419–476.

This is a comprehensive account of the writer's studies conducted at the Biologische Reichanstalt, Berlin-Dahlem, on the influence of various environmental conditions on perithecial production in seven Hypocreaceae which included *Neocosmospora vasinfecta* from chickpea obtained from India.

158. KUHNHOLTZ-LORDAT, G. 1941. Rust of chickpea (in French). Progres Agricole et Viticole: 116:25.

Description of chickpea rust caused by *Uromyces ciceris-arietini*.

159. KUNZRU RAMA, and S. SINHA. 1966. 'Cicerin' a

new phytoalexin associated with blight of gram. *In* Plant Disease Problems – Proc. 1st International Symposium on Plant Pathology, Indian Phytopath. Soc., New Delhi, pp. 724–732.

Proposes that the status of a phytoalexin be given to the antibiotic principle which diffuses into the inoculation droplets during the course of interaction between *Ascochyta rabiei* and the pod tissues of chickpea. The name "Cicerin" is suggested. The inhibitory principle is composed of two phenolic compounds, as established chromatographically.

160. KUSHWAHA, L. S. 1971. Studies on physiology of *Fusarium* pathogenic on gram and lentil. Thesis submitted to the J. N. Agricultural University, Jabalpur for the degree of M.Sc. (Ag.) Plant Pathology. 36 pp.

Both the isolates of *Fusarium* were associated with roots and were pathogenic on chickpea and lentil and *vice versa*. Five chickpea cultivars – T-1, T-2, Pb-7, BR-77 and S-24-2-5 – showed resistance to the disease. Optimum temperature for growth of both isolates was 25° C. Best growth was observed at pH 6; lactose was the best source of carbon, followed by maltose, starch, and glycerol for chickpea isolates.

For both isolates, aspargine, potassium nitrate, and sodium nitrate were good sources of nitrogen; potassium sulphate was best source of sulphur, followed by magnesium sulphate; and potassium dihydrogen orthophosphate was the best source of phosphorus and potassium for both isolates.

161. KUZ'MINA, G. 1966. Antibiotics against wilt (in Russian). Zashch. Rast., Mosk. 11:31.

Seed treatment of pea and chickpea with 10, 2, and 0.5% phytobacteriomycin at 0.001, 0.01, and 0.02 percent, and dusting with 1 and 2% trichothecin increased seed germination by 5 to 10 percent, improved yield, and reduced the incidence of *Fusarium oxysporum*.

162. LABROUSSE, F. 1930. Anthracnose of the chickpea (*Cicer arietinum*) (in French). Rev. Path. Veg. et Ent. Agr. 27:174–177.

An account of a disease of chickpeas (originally recorded in 1929 from Morocco, where it is stated to be very destructive) studied on living plants in experimental plots at Versailles. The disease affects all aerial organs of the host. On leaflets it causes rounded or elongated spots bearing irregularly dispersed brown dots, surrounded with a brownish-red margin, and measuring 8 to 10 by 5 to 6 mm in diameter. On the green pods the spots are superficial and bear black dots disposed in several more or less concentric circles; the seeds do not appear to be attacked. On the stem and petioles the spots are brown, elongated (3 to 4 cm in length), bear black dots, and may girdle the attacked organ, in which case the portion above the point of attack rapidly dies. The main stem may be girdled by the organism at the collar; the whole plant then dies.

Pycnidia borne on the spots are sub-globular, sub-epidermal, 100 to 260 by 160 to 180 μ in diameter, with a raised ostiole 20 to 25 μ in diameter. Pycnospores are continuous, usually cylindrical with rounded ends, 6 to 12 by 4 to 6 μ (average 9 to 10 by 4 to 5 μ) borne on sterigmata 4 to 8 by 2 to 3 μ in diameter. The large-sized spores are occasionally slightly constricted in the middle. Two-celled spores were not found in nature, but a few were observed in pure cultures.

The author considers the causal organism to be *Phyllosticta rabiei*, in spite of the morphological differences between it and Trotter's diagnosis. The fact that garden peas growing in the vicinity of the infected chickpeas remained immune would indicate that the fungus is not *Ascochyta pisi*, unless it could be demonstrated that biological strains exist in the latter.

Owing to the conditions under which the crop is extensively cultivated in Morocco, the author considers that control of the disease by spraying with Bordeaux mixture, as recommended by Del Canizo, is not commercially practicable there. The development of resistant cultivars would appear to be more promising.

163. LABROUSSE, F. 1931. Anthracnose of chickpea (in French). Rev. Path. Veg. et Ent. Agr. 28:226–231.

In further investigations into the disease of chickpeas, formerly attributed to *Phyllosticta rabiei*, the author observed that 2 to 4 percent of the spores in the pycnidia developing on inoculated plants were bicellular and considers that the fungus should be referred to the genus *Ascochyta*, which also establishes a more satisfactory connection between it and the diseases of common peas caused by *A. pisi*, *A. pinodella*, and *A. pinodes*. All have as a common characteristic the production of similar lesions on the stems and foliaceous organs, whereas *Phyllosticta* comprises only leaf-attacking species. *Ascochyta* is preferred to *Diplodina* because the latter includes only stem-attacking species and also to the groundnut of priority. The author accordingly proposes the name *A. rabiei* (Passerini) nov. comb. for the chickpea organism.

In a field test, rows of chickpeas were planted alternatively with rows of *Vicia faba*, *V. sativa*, *V. hirta*, *V. macrocarpa*, *Lathyrus sylvestris*, garden peas, and lentils, and fragments of chickpeas killed off by the disease were deposited on the rows. As soon as the plants showed above the soil all chickpeas were killed, but the other species continued to be unaffected in spite of repeated sprinkling with an aqueous suspension of the spores of *A. rabiei*.

On carrot agar *A. rabiei* forms a scanty cream-white mycelium with numerous pycnidia blackening the medium; the spores are a very pale pink, almost white in the mass. Under identical conditions, *A. pisi* forms an abundant rose-pink mycelium, the pycnidia are of a light color, and the spores in the mass are a bright carrot-red.

Of 36 different types of chickpeas inoculated with *A. rabiei*, three remained almost completely unaffected in spite of repeated sprinkling with an aqueous suspension of the spores; two of these types are fit for human consumption while the

third is suitable for feeding to animals. Further efforts to discover resistant types are in progress.

164. LABROUSSE, F. 1931. Observations on some diseases of market garden plants (in French). Rev. Path. Veg. et Ent. Agr. 28:286–289.

Eleven of 167 types of chickpea showed definite resistance to anthracnose (*Ascochyta rabiei*); none of the Indian types tested was resistant. When two susceptible types and one resistant type were sown at intervals of 10 days from 1 Apr until 20 Jun, each retardation of date of sowing increased the time lapsing between emergence above ground and complete destruction of the susceptible plants (38 days for plants sown on 1 Apr, 67 days for those sown on 20 Jun).

165. LOPEZ GARCIA, H. 1974. Inheritance of the character resistance to wilt (*Fusarium* sp.) in chickpea (*Cicer arietinum*) under field conditions (in Spanish). Agricultura Tecnica Mex. 3:286–289.

Resistance was evaluated in the F_2 of 19 reciprocal crosses between resistant and susceptible cultivars. The results suggest that two pairs of genes are involved and that susceptibility is dominant.

166. LUKASHEVICH, A. I. 1958. Control measures against ascochytosis of chickpea (in Russian). J. Agric. Sci., Moscow 5:131–135.

In the steppe region of the Ukrainian SSR, chickpea is attacked by *Ascochyta rabiei*, especially in warm weather with frequent rains. The disease is seed-borne and can also spread from plant debris, it was checked by sowing later in April and at 3-cm depth. Application of K [at 45 (?kg/ha)] before sowing in 1951 gave only 7.5 percent diseased plants compared with 18 percent with no fertilizers. Dusting dry seeds with 2:1,000 and previously soaked seeds with 1:1,000 granosan gave higher germination and less infection, especially at the lower rate. Treatment immediately before sowing gave 17.8 percent less infection than the nontreated. Spraying the plants with S compounds (3% water suspension at 500–600 l/ha) gave good control and increased yield from 31 to 82.8 percent.

167. LUKASHEVICH, A. I. 1958. Peculiarities of the parasitism of the causal agent of ascochytosis of chickpea, and their role in the accumulation of infection (in Russian). Rep. Acad. Sci. Ukr. 7:788–792.

From research at the All-Union sci. Res. Inst. for Maize it was found that *Ascochyta rabiei*, normally a parasite on chickpea, develops also as a saprophyte on the death of the host. Seed infection may increase 1.5 to 2-fold when harvesting on the Ukrainian steppe is late or where plants have been stacked in ricks for a long time before threshing in rainy weather. Post-harvest debris left on the fields over winter is also heavily infected.

168. LUTHRA, J. C., and K. S. BEDI. 1932. Some preliminary studies on gram blight with reference to its cause and mode of perennation. Indian J. Agr. Sci. 2:499–515.

The chickpea crop in the north Punjab has been heavily damaged by blight; the responsible fungus was identified as *Phyllosticta rabiei* notwithstanding its somewhat smaller pycnidia (185 by 55 μ compared with 200 by 167 μ for the type species). The portions above the affected aerial parts wilt and bend over. The fungus germinated in 8 to 16 hr in gram seed or leaf extracts at 15°, 20°, and 25° C, but not at 8° to 10° or 32°. Inoculation experiments on chickpea plants in pots gave positive results after 4 days. Seeds have been found naturally infected in the pod by *P. rabiei*, which appears to penetrate from the ovary wall into the testa at the point of contact and thence to pass to the cotyledons. The hyaline, branched, septate hyphae of the fungus have been found in and between the cells of the testa and cotyledons. Weight and germinative capacity of diseased seeds is usually reduced (in 100 healthy seeds, germination was 99.3%; in 100 infected seeds 44.6%. Healthy seeds weighed 12.57 g; infected seeds 3.95 g). Field observations and experiments (described) showed that *P. rabiei* is carried on the seed.

169. LUTHRA, J. C., A. SATTAR, and K. S. BEDI. 1935. Life history of gram blight *Ascochyta rabiei* (Pass.) Lab. = *Phyllosticta rabiei* (Pass.) Trotter and measures for its control. Proc. Indian Sci. Cong, 22:373–374.

In addition to emphasizing the seriousness of the disease in northwest India (prepartition) and describing symptoms and the causal fungus, the authors have stated that the fungus perennates on seed and on plant debris in soil. Suggested control measures include sowing healthy seed and destroying diseased plant material after harvest. Burying plant debris in slightly moist soil within a month after harvest is recommended for killing the fungus.

170. LUTHRA, J. C., A. SATTAR, and K. S. BEDI. 1935. Life history of gram blight (*Ascochyta rabiei*) (Pass.) Lab. = *Phyllosticta rabiei* (Pass.) Trot. on gram (*Cicer arietinum* L.) and its control in the Punjab. Agr. Live-Stk. India 5:489–498.

A popular account of the work done to date in the investigation of chickpea blight (*Ascochyta rabiei*) in the Punjab. Additional points of interest follow. Infected gram material remaining in the field from other crop is an important source of primary infection for the next; experiments having shown that *A. rabiei* remains alive for more than 2 years in such material, unless it is buried at least 2 inches deep in the soil, in which case the fungus is killed within a month provided sufficient soil moisture is

present. Usually primary infection foci in a field are limited and isolated, but in windy and wet early seasons the infection is rapidly spread by rain and by infected debris blowing over the field. Infected debris is apt to be broken off from brittle diseased plants and transported for hundreds of yards by strong winds. It was also conclusively shown that soil infection with the fungus plays no part in the perpetuation of the disease. The minimum temperature for growth and spore germination was below 10°, the optimum 20°, and the maximum about 32.5° C. Very few spores germinate and cause infection during December and January, due to the very low temperature which prevails at that time; infection usually occurs in February and March, when temperature rises to 70° or 80° F.

For purposes of control it is recommended that infected chickpea plants be removed from the fields at harvest time or ploughed under during summer, at least 2 or 3 months before sowing the new crop. Infected straw may be safely fed to cattle, as the spores were shown not to survive passage through the animals. Seed should be obtained from regions where the disease does not occur. Observations made during several years indicated that chickpea sown in mixture with wheat, barley, taramira (*Eruca sativa*), sarson (*Brassica campestris*) (var. *sarson*), or any other suitable crop suffers less from the disease than do pure stands, and this measure is also recommended wherever possible to minimize the losses caused by blight.

171. LUTHRA, J. C., A. SATTAR, and K. S. BEDI. 1938. The control of the blight disease of gram by resistant types. Curr. Sci. 7 (2):45–47.

In further work carried out in the Punjab on chickpea blight (*Ascochyta rabiei*), 187 types of chickpea obtained from America, Europe, and different parts of India were tested for resistance by spraying with an aqueous suspension of the pycnospores or spreading diseased chickpea debris over the plants. The only types that showed resistance were Nos. 281, 199, and 4F 32 (all very resistant), and 180 (fairly resistant), all of which originated from France but were supplied by the Bureau of Plant Industry, Washington. The type selected to replace the local seed was 4F 32, renamed for purposes of convenience F8. It is expected that in 1940 about 25,000 maunds (1 maund = 82.284 lb) of seed of this type will be available to local growers.

172. LUTHRA, J. C. 1938. India: some new diseases observed in the Punjab and mycological experiments in progress during the year 1937. Int. Bull. Pl. Prot. 13 (4):73–74.

Rhizoctonia sp. was found on chickpea.

173. LUTHRA, J. C., A. SATTAR, and K. S. BEDI. 1939. Variation in *Ascochyta rabiei* (Pass.) Labr., the causal fungus of blight of gram (*Cicer arietinum* L.). Indian J. Agr. Sci. 9:791–805.

Five cultural forms of the fungus, pathogenic to chickpea, were biologically identical.

174. LUTHRA, J. C., and A. SATTAR. 1941. Control of gram blight in the Punjab. Indian Fmg. 2:66–69.

Following a summary of the economic importance symptoms and mode of perpetuation of chickpea blight (*Mycosphaerella rabiei*), the writers describe the control measures which have been in progress against the disease for several years past at the Agricultural Farm, Campbellpur, Punjab, with special reference to the performance of resistant cultivars, notably F8. The average yield of this strain, 13 maunds (1 maund = 82.284 lb) per acre, in tracts of widespread devastation from the disease, compares favorably with that of the leading Punjab types 7 and 15. Total output from an area of 2,086 acres planted with F8 seed in 1939 amounted to 22,032 maunds, with an average yield of 10½ maunds per acre. The discovery of this type is regarded as an important contribution to the development of disease-resistant strains of Indian farm crops, and seed has been issued to the public for replacement of the local type, especially in districts where the blight has long been epidemic.

175. LUTHRA, J. C., A. SATTAR, and K. S. BEDI. 1943. Further studies on the control of gram blight. Indian Fmg. 4:413–416.

During 1939–40, a supply of about 22,000 maunds (808 tons) of seed of the F8 line of chickpea, which is highly resistant to blight (*Mycosphaerella rabiei*) and also yields satisfactorily under the climatic conditions prevailing in the north Punjab, became available to farmers locally. In 1940–41, this seed was sown over an area of about 40,000 acres. The season was marked by abnormal drought, and a widespread outbreak of wilt (*Fusarium orthoceras* var. *ciceri*) occurred in many places. F8 was severely affected, the evidence demonstrating that this line should be used to replace the local types susceptible to blight only in the districts of Rawalpindi, Jhelum, Gujaral, Attock (excluding Mukbad and Lana) and Shahpar (excluding Khushab tehsil), where, if soil infection by the wilt organism is present, it is so only in a mild form.

In these locations, F8 should be sown only when the season has become sufficiently cool, i.e., 10 days to a fortnight after the time generally assumed to be best for sowing the local cultivars. As far as possible, the initial amount of moisture in the fields to be planted should be the same as for wheat. As F8 seed is about 50 percent heavier than the local types, the seed rate should be increased correspondingly, in order to secure a normal stand.

In places like Ferozepore and Hissar, chickpea blight is rare. Drought is prevalent in these areas and most of the damage done to chickpea is due to wilt or to unfavorable soil factors. In these districts a wilt-resistant cultivar is required, whereas in localities such as Lyallpur, Lahore, and Amritsar, where blight and wilt both generally exist, a cultivar resistant to both diseases is needed.

In selection work carried out to find a cultivar possessing an

equally high resistance to blight without the disadvantages of F8, small-seeded natural hybrid No. 62–18 gave the best performance.

176. MADEN, S., D. SINGH, S. B. MATHUR, and P. NEERGAARD. 1975. Detection and location of seedborne inoculum of *Ascochyta rabiei* and its transmission in chickpea *(Cicer arietinum)*. Seed Sci. & Tech. 3:667–681.

Of chickpea seed samples from Central Anatolia, Turkey, 70 percent were found to be infected with *Ascochyta rabiei*. The standard blotter method – using five seeds per petri dish and 12 hr NUV 12 hr darkness cycles at 22°C – was found most suitable for detecting the fungus. The inoculum occurred as spore contamination and mycelium in the seed coat alone or in seed coat and embryo. Pycnidia were observed only in the seed coat of seeds having deep lesions. Whole mount preparations and microtome sections showed that the inter- and intracellular mycelium was localized to lesions. Pycnidia were subepidermal and contained mature spores. Pycnidiospores obtained from the seed surface and pycnidia from 14-month-old seed, stored at 3° ± 2°C, showed 33 percent germination. Light and temperature responses of *A. rabiei* on potato-dextrose-agar revealed that optimum colony growth took place at 19°C. Pycnidial formation was maximum under NUV, but failed in darkness. Both superficial and deep infections were equally potent in the transmission of the disease. The fungus was found to be highly pathogenic to seed and 40-day-old plants.

177. MAHMOOD, M., and D. N. TIWARY. 1971. Comparative studies on the six isolates of *Ozonium texanum* var. *parasiticum*. Sci. & Cult. 37:487–488.

The fungus causes root and collar rot of chickpea and several crops in Bihar. Growth was fastest on potato-dextrose agar, but good also on a carbon-deficient medium. Isolates were grouped into four strains. Some tended to develop a perfect state. The toxic principle produced was oxalic acid. Root and collar rot of potato was controlled by rotation with maize. Sclerotial germination was inhibited by 0.2% formalin, 0.4% Bordeaux, 0.2% captan, or 0.2% thiram.

178. MALIK, S. A., and M. A. KHAN. 1943. Parasitic fungi of the North-West Frontier Province. Indian J. Agr. Sci. 13:522–527.

Lists 105 fungal pathogens of plants collected, mostly by the senior author, in the Northwest Frontier Province during the last 5 years. Among the records listed is *Fusarium orthoceras* var. *ciceris* on chickpea.

179. MANUCHERI, A., and MESRI. 1966. Fusarium wilt of chickpea (in Farsi). Iran. J. Pl. Path. 3 (3):1–11.

Fusarium lateritium var. (f. sp.) *ciceri* is serious on chickpea in Iran, infecting 17 percent of the crops at flowering time. Diseased plants turn yellow from the bottom to the top and the xylem turns black. Seed treatment with mercury compounds is recommended for control.

180. MARRAS, F. 1961. *S. minor*, parasite of legumes (Pea, Lentil, Chickpea, and Haricot Bean) in Sardinia (in Italian). Studi sassaresi, Sez. III, 9 (2), 13 pp.

Opt. temp. for the fungus on carrot agar was 20 to 25°C., max. 30°, min. 5°; it grew well at pH 4 to 10, opt. around neutral. Of the four hosts, bean (*Phaseolus vulgaris*) is new for Italy and the other three are new for the pathogen. It had not previously been reported from Sardinia, where it was particularly severe in pea and lentil fields along the NW coast. Inoculation tests showed that this Sardinian str. could also infect broad-bean, sunflower, and lettuce, with greater virulence on spp. with delicate tissues.

181. MATHUR, B. L., and R. L. MATHUR. 1965. Metabolites of *Fusarium oxysporum* f. *cumini* in relation to cumin wilt. Indian Phytopath. 18:335–339.

Seedlings of chickpea and other crops wilted by filtrates of *Fusarium oxysporum* f. sp. *cumini*, but browning symptoms did not appear. The toxin retained its effect after autoclaving for 10 min at 6 lb and dilution ×6.

182. MATHUR, R. S. 1954. Diseases of pulse crops in Uttar Pradesh. Agr. Ani. Husb., Uttar Pradesh 5 (1):24–28.

Brief notes on the economic importance, symptoms, and control of the most important diseases of pulses in Uttar Pradesh, India. Describes rust (*Uromyces ciceris-arietini*) as an important disease of chickpea that appears late in the season and generally causes little damage.

183. MATHUR, R. S., J. S. JAIN, and S. C. ATHEYA. 1960. Resistance of gram varieties to Fusarium wilt in Uttar Pradesh, 1949–1958. Curr. Sci. 29:403.

Ninety-five lines were screened for wilt (*Fusarium orthoceras* var. *ciceri*) resistance in a wilt-sick nursery during 1949–1958. Six lines found to be resistant were 4338–15 (106), 4317 (100), 4317–28 (93), 4318–12 (88), 4313–2 (93), and 4409–9 (101).

184. MATHUR, R. S., S. C. ATHEYA, and J. N. MISRA. 1964. Wilt resistance tests of gram varieties in Uttar Pradesh. Labdev. J. Sci. & Tech. 2:265–266.

Fifty-two cultivars/lines were screened for wilt (*Fusarium orthoceras* var. *ciceri*) resistance in a wilt-sick nursery during 1959–63. A single line–106, received from Bihar State–was found resistant (less than 10% incidence).

185. MATHUR, R. S., and D. C. KUREEL. 1965. Search for resistance to gram wilt in Uttar Pradesh, 1964. Labdev. J. Sci. Tech. 3 (1):74.

In field screening, no line was resistant. Line 106, earlier found resistant, was susceptible in current test.

186. MATHUR, S. 1968. Investigations of inter-relationships between soil microorganisms, pathogens and hosts in relation to wilt of gram, *Cicer arietinum* L. Ph.D. thesis, Agra University, Agra, India.

187. MATHUR, S., and S. K. CHAUHAN. 1968. Metabolic alterations in gram plants caused by three wilt causing organisms *Fusarium oxysporum* f. *ciceri*, *Sclerotium rolfsii* and *Rhizoctonia solani*. J. Vikram Univ. (Ujjain, India) 12:27–36.

Qualitative and quantitative determinations of amino acids, sugars, and organic acids in healthy and diseased chickpea plants were made by paper chromatography. A marked change was noted in amino acids, sugars, and organic acids spectrum of roots and shoots of plants infected with either pathogen. In plants infected with *F. oxysporum* f. *ciceri* 10 amino acids, 6 sugars, and 10 organic acids were detected. Plants infected with *Sclerotium rolfsii* reveal the presence of 11 amino acids, 2 sugars, and 10 organic acids. Content of amino acids, sugars and organic acids evidently depends upon the circumstances of host growth as influenced by the presence of different pathogens.

188. MATHUR, S., and S. K. CHAUHAN. 1972. A comparative study of rhizosphere of gram (*Cicer arietinum* L.) in relation to its wilt diseases caused by different fungi. J. Indian Bot. Soc. 51 (3/4):267–274.

Physical and chemical conditions of the rhizosphere and the populations of fungi, actinomycetes, and bacteria were studied in soils separately inoculated with *Fusarium oxysporum* f. sp. *ciceri*, *Rhizoctonia solani* and *Sclerotium rolfsii*. Different rhizosphere conditions developed with each pathogen, but the population of microorganisms was always higher with diseased than with healthy plants. Qualitative and quantitative differences were found in the mycoflora of various rhizospheres. Some of the fungi, actinomycetes, and bacteria isolated were antagonistic to the wilt pathogens.

189. MATHUR, S. B. 1962. Soil conditions in relation to some diseases of crops. Agra Univ. J. Res. (Sci.) 11:105–107.

At Dept. Bot., Agra Coll. the opt. temp. for development of *Sclerotium rolfsii* in roots of *Cyamopsis psoraloides* in constant-temp. soil tanks was 25 to 30°C and max. wilt of chickpea occurred at 30°, corresponding with max. growth of the fungus in culture at 30°. The incidence of both diseases was increased by low soil moisture and acid (pH 5.6 to 6.6) conditions, highest in loamy soils, and reduced by the addition of humus. Under conditions promoting infection, 97.5 percent mortality occurred in *Cyamopsis psoraloides* and 70 percent in chickpea, compared with 27 and 30 percent in environments most favorable for the hosts.

190. MATHUR, S. B. 1962. Effect of soil moisture on root-rot of guar (*Cyamopsis psoraloides* DC.) and wilt of gram (*Cicer arietinum* L.) caused by *Sclerotium rolfsii* Sacc. Agra Univ. J. Res. (Sci.):295–302.

Results of pot experiments at Agra College on percentage seedling emergence and postemergence mortality at 4-day intervals under different soil moisture conditions. Maximum mortality (76.67%) of *Cyamopsis psoraloides* occurred at 15 percent moisture and that of chickpea (93.33%) at 10 percent. Mortality was greater in seedlings than in older plants.

191. MATHUR, S. B. 1963. Effect of soil temperature on root-rot of guar (*Cyamopsis psoraloides* DC.) and wilt of gram (*Cicer arietinum*) caused by *Sclerotium rolfsii* Sacc. Agra Univ. J. Res. 12:261–269.

Maximum wilt of chickpea was 24 percent at 30°C and only 4 percent at 25°. Mortality rate was highest at 30°. It was concluded that chickpea is relatively more susceptible than guar to *S. rolfsii* at similar soil temperatures.

192. MATHUR, S. B. and S. SINHA. 1968. Disease development in guar (*Cyamopsis psoraloides* DC.) and gram (*Cicer arietinum* L.) attacked with *Sclerotium rolfsii* under different soil pH conditions. Phytopath. Z. 62:319–322.

In sand culture experiments at Agra College, India, infection in guar was max. at pH 6.6 (54.2%) and in chickpea at 5.6 (89.6%). Alkaline conditions reduced the disease in both crops. At pH 8.4, rate of mortality was 16.7 percent in guar and in chickpea 35.4 percent, and at pH 9.2, 6.3 and 20.8 percent respectively. Liming the soil appears advisable.

193. MATHUR, S. B., and S. SINHA. 1970. Role of manuring in control of root-rot of guar (*Cyamopsis psoraloides* DC.) and wilt of gram (*Cicer arietinum* L.) caused by *Sclerotium rolfsii* Sacc. Mycopath. Mycol. Appl. 40:155–159.

In further studies, infection by *S. (Corticium) rolfsii* was reduced from 71.9 to 54.7 percent in guar and from 82.1 to 64.3 percent in chickpea by application of farm manure (compost). Heavy manuring is recommended for maximum control.

194. McKERRAL, A. 1923. A note on Fusarium wilt of gram in Burma and measures taken to combat it. Agr. J. India 28:608–613.

After a reference to the economic importance of chickpea in Burma, the author states that in some parts of the country this crop is severely attacked by wilt caused by a *Fusarium* closely allied to the fungus (*F. udum*) that attacks *Cajanus indicus* in India, and that the only hope of controlling the disease lies in use of resistant varieties.

Of a large number of types of chickpea tested for yield during several years at the Padu Agricultural Station in the Sagaing district, best results up to 1918 were obtained with a variety of black chickpea found to be more resistant than the usual Burmese type; it did not, however, generally find favor with buyers in Burma and its resistance to the disease was not maintained. In 1921, yield tests were arranged, both at Padu and Mandalay, between the Burmese types and a selection from a cultivar known as Karachi, which showed the latter strain to be satisfactory both commercially and from the point of view of resistance to wilt. In addition, the 25 types described in Memoirs Dept. Agric. India, Bot. Ser., vii, 6, 1915, were tested at Pandu in 1922 and 1923; of these, Nos. 1 to 9 were completely destroyed by the fungus and Nos. 10, 14, 16, and 24 were attacked but not completely destroyed, while the rest appeared to be resistant. With the exception of No. 2, however, they seem to be too late for Burma. As the Karachi cultivar was found to be much superior to the Burmese type, it was decided to replace the latter by the former in those localities where the disease is known to be prevalent. Returns made independently by the Land Records Department showed the area under the new cultivar as 28,000 acres in 1923. Initial progress has thus been satisfactory, and a vigorous policy will be pursued with a view to eliminating the Burmese cultivar from all localities where the least signs of disease are seen.

195. McRAE, W. 1924. Report of the Imperial Mycologist. Sci. Rep. Agr. Res. Inst. Pusa, 1923–24:41–51.

Experiments with the wilt of chickpea have so far failed to establish the causal relationship of the various strains of *Fusarium*, isolated from diseased wilted plants in different parts of India. It is suggested that the soil temperatures at Pusa, where chickpea wilt is generally absent, may be too low to permit infection, since various wilt-producing species of *Fusarium* have relatively high soil temperature limits for infection.

196. McRAE, W. 1926. Report of the Imperial Mycologist. Sci. Rep. Agr. Res. Inst. Pusa, 1925–26:54–69.

Tests of resistance of chickpea to wilt (*Fusarium* sp.) carried out by artificial inoculation gave negative results, while in naturally infested soil 17 out of the 25 types of chickpea tested were found to be susceptible.

197. McRAE, W. 1928. Report of the Imperial Mycologist. Sci. Rep. Agr. Res. Inst. Pusa, 1926–27:45–55.

Three of the eight types of chickpea which did not contract wilt (*Fusarium* sp.) in the previous year's tests became diseased during the current season; in 2 years' trials 5 (15, 16, 21, 23, and 24) of 25 types have remained immune.

198. McRAE, W. 1928. Report of the Imperial Mycologist. Sci. Rep. Agr. Res. Inst., Pusa, 1927–28:56–70.

A leaf disease of chickpea, caused by a species of *Mystrosporium* with single, ovate, muriform conidia measuring 13 to 35 by 9 to 26 μ (average 22 by 19 μ), was observed for the first time at Pusa after a spell of wet misty weather during January and February.

199. McRAE, W. 1929. India: new diseases reported during the year 1928. Intern. Bull. Plant Prot. 3:21–22.

An undetermined species of *Fusarium* was responsible for wilt of chickpea in the Coimbatore and Bellary districts.

200. McRAE, W. 1930. Report of the Imperial Mycologist. Sci. Rep. Agr. Res. Inst., Pusa, 1928–29:51–66.

Artificial infection experiments showed 30 types of chickpea to be susceptible to the blight previously reported as due to a species of *Mystrosporium*. Growth of the fungus in culture was checked at 34° C, when spore production almost ceased.

201. McRAE, W. 1932. Report of the Imperial Mycologist. Sci. Rep. Agr. Res. Inst., Pusa, 1930–31:78–86.

Inoculation of chickpea seedlings with a species of *Fusarium* isolated from wilted plants gave positive results, the number of successful infections being higher at 24° to 27° than at 18° to 20° C. *Rhizoctonia (Corticium) solani* and a new species of *Sclerotium* were found together in the collar and roots of chickpea plants, causing shrinking, cracking, and ultimate death. Both organisms proved to be parasitic. The incidence of *Mystrosporium* leaf blight on chickpea was relatively slight, only the T. 68 cultivar being appreciably damaged. Seed disinfection in 0.5% formalin killed the spores without impairing germination.

202. MEHTA, P. R., and B. B. MUNDKUR. 1946. Some observations on the rust of gram (*Cicer arietinum* L.). Indian J. Agr. Sci. 16:186–192.

Description of the morphology and symptoms of chickpea rust (*Uromyces ciceris-arietini*). Uredospores germinated well in 0.05% malic acid solution and in distilled water, 20° to 26°C being the optimum temperature both for germination and

growth of the germtubes. Uredospores stored at room temperature or in soil in pots lost their viability in 2 to 4 weeks, but if stored at 6° they remained viable for a longer time. It is therefore concluded that rust epidemics in India are not due to over-seasoning uredospores. Gram leaves floating on sugar solutions and plants growing in pots were readily infected by uredospores from the previous season stored at 6°. The incubation period was about 27 days at 8° but only 11 to 13 days at 20° to 24°. Teleutospores could not be germinated. Different chickpea cultivars were tested for resistance, some showed seedling resistance, which was lost at a later stage. Cultivar IP82, susceptible in the seedling stage, was only mildly attacked later. Of 60 cultivars cultivated at Karnal, 29 bore no rust pustules in 1939.

203. MEHTA, P. R., D. N. GARG, and S. C. MATHUR. 1950. Important diseases of food crops, their distribution in India and Uttar Pradesh. Tech. Bull. Dep. Agr. U.P. 2:1–13.

Tabulated list of fungal and virus diseases of food crops in India and Uttar Pradesh, their distribution in the region, time of appearance, severity, and estimated losses in U.P. Resistant cultivars are included. Among the more important and widespread pathogens listed is *Fusarium orthoceras* var. *ciceri* on chickpea. In one year of field trials, 4313–2 and T-87 were found resistant.

204. MISHRA, J. N. 1955. Wilt of gram (*Cicer arietinum* L.) in Bihar. Curr. Sci. 24:210.

Wilting of chickpea plants in the heavy soils of south Bihar, India, sometimes causing death of 5 to 10 percent of the plants, was found to be due to *Ozonium texanum* which is believed to be identical with *O. texanum* var. *Parasiticum*.

205. MISHRA, R. P., N. D. SHARMA, and L. K. JOSHI. 1975. A new disease of gram (*Cicer arietinum* L.) in India. Curr. Sci. 44:621–622.

Colletotrichum dematium has been reported to affect all aerial parts in severe form under high humidity conditions.

206. MITRA, M. 1931. Report of the Imperial Mycologist. Sci. Rep. Agr. Res. Inst., Pusa, 1929–1930:58–71.

Strain of *Macrophomina phaseoli* from chickpea was able to infect potato.

207. MITRA, M. 1935. A new blight disease of gram. Proc. Indian Sci. Cong. 22:374.

A new blight disease caused by a species of *Mystrosporium* has been reported from Pusa, Bihar (India). The fungus forms roundish spots, 0.5 to 4 mm in diameter, of yellowish brown color with a pale-reddish ring. In severe cases leaflets fall off and the disease spreads to petioles and stems. The fungus is seed-borne; seed treatment with formalin (0.5%) controlled the disease. Secondary infection can be checked by two to three sprays of 1% Bordeaux mixture. Several cultivars (not specified) were found resistant and Type 68 was found highly susceptible.

208. MITRA, M. 1936. Report of the Imperial Mycologist. Sci. Rep. Agr. Res. Inst. Pusa, 1933–34:139–167.

Infection of chickpea by a *Mystrosporium* was very severe on Type 68 and moderately so on Types 48, 49, and 67; on 18 types the attack was slight, and on 34 only a trace of blight was present.

209. MORRALL, R. A. A., and D. L. McKENZIE. 1974. A note on the inadvertent introduction to North America of *Ascochyta rabiei*, a destructive pathogen of chickpea. Plant Dis. Reptr. 58:342–345.

A. rabiei is newly recorded in North America from Saskatoon causing extensive damage to plots of chickpea. It is assumed to have been introduced with imported seed, but its origin cannot be determined. Of a large number of cultivars tested, very few were resistant.

210. MOSSAHEBI. 1968. Chickpea diseases (in Farsi). Iran. J. Pl. Path. 4 (4):1–5.

Wilt caused by *Fusarium* (?) *lateritium* f. sp. *ciceri* is the most serious disease of chickpea in Iran. The fungus attacks the plant directly or indirectly through wounds made by nematodes and insect larvae. General yellowing of the leaves and discoloration of vascular elements are the main symptoms. Alfalfa mosaic, bean yellow mosaic, and cucumber mosaic viruses also occur on this host.

211. MOTIRAMANI, D. P. 1947. Preliminary study in diagnosis of gram diseases (*Cicer arietinum* L.). Part 1. Comparison of mineral nutrition of healthy and diseased plants. Part 2. Study of the bronzing of gram. Part 3. Inoculation experiment on gram wilt. Assoc. I.A.R.I. thesis, Indian Agr. Res. Inst. New Delhi. 85 pp.

212. MUJICA, R. F. 1955. Studies on sclerotiniosis (in Spanish). Agricultura Tec., Santiago 15:64–74.

At the Departamento de Investigaciones Agricolas, Santiago, *Sclerotinia sclerotiorum* was identified on 18 cultivated species from Chile, sunflower being its most important host. Pathogenicity trials proved susceptibility of chickpeas in addition to

other crops. Development of the fungus in the soil is more rapid with more frequent irrigation and when the sclerotia are placed at lesser depths. Apothecial formation is favored by soil pH approaching neutral (pH 7.28).

213. MUNDKUR, B. B. 1946. Report of the Imperial Mycologist. Sci. Rep. Agr. Res. Inst., New Delhi, for the triennium ended 30 June, 1944:57–63.

In experiments on the effect of sowing date on the incidence of chickpea wilt (*Fusarium orthoceras* var. *ciceris*), the crop sown in September (?1942), was almost destroyed by the disease, which, however, was much less in the October sowings. Early sowing was also found to favor attack by foot rot (*Operculella padwickii*). When *Trichoderma lignorum* (*T. viride*) was mixed with soil highly infested with *O. padwickii*, no reduction in infection of the chickpea was observed over a period of 3 years. In 1943–44 the general level of infection was rather higher in plants from non-vernalized seed than from vernalized.

214. MURAYAMA, D. 1966. On the witches' broom diseases of sweet potato and leguminous plants in the Ryukyu Islands (in Japanese). Mem. Fac. Agr. Hokkaido Univ. 6 (1):81–103.

Results of studies in 1962–63. Sweet potato witches' broom, first recorded in the islands in 1947, causes serious crop losses. Witches' broom symptoms were found on 54 species in 18 families, some affected by sweet potato virus and some by that of leguminous plants. Leafhoppers failed to transmit the former, but *Nesophrosyne orientalis* readily transmitted legume witches' broom to broad-bean, pea, bean (*Phaseolus vulgaris*), adzuki bean (*P. angularis*), chickpea, soybean. Seedlings grown from seeds of infected plants were healthy.

215. MURTHY, D. M., and W. H. PIERCE. 1937. Common mosaic of the garden pea, *Pisum sativum*. Phytopathology 27:710–721.

Symptoms induced by common pea mosaic (pea virus 3) on garden peas in Idaho range from severe yellow mottling and dwarfing (Alderman, World's Record, and Market Surprise varieties) to less intense mottling and general chlorosis (Alaska and Telephone). In the greenhouse blue lupins (*Lupinus angustifolius*), chickpeas, and grass peas (*Lathyrus sativus*) inoculated with pea virus 3 developed apical necrosis (spreading throughout the plants in the two first-named) and severe foliar mottling, while common vetch (*Vicia sativa*) leaves were mottled and curled.

216. NALEPINA, L. N. 1971. On the specialization of *F. oxysporum* (in Russian). Mikol. i Fitopatol. 9:271–275.

Although the 23 isolates from pea, bean, chickpea, lupin, lucerne, broad-bean, wild pea, cotton, cucumber, melon, cabbage, maize, and tomato were most pathogenic to their original hosts, they also infected other plants. Narrow specialization was not observed. The most pathogenic were isolates from cotton, infecting all the other plants, and also those from chickpea.

217. NARASIMHAN, R. 1929. A preliminary note on a *Fusarium* parasitic on Bengal gram (*Cicer arietinum*). Madras Agr. Dep. Year Book, 1928:5–11.

In January 1928, specimens of wilted chickpea plants were received from Bellary district, and about the same time a similar condition was observed at Coimbatore. Examination of the diseased plants revealed in some cases a species of *Fusarium* and in others a *Rhizoctonia*.

The first symptom of the disease in the field is a drooping of leaves, followed by pronounced wilting and necrosis of the tissues in the collar and main roots. Affected plants easily break away at the collar when pulled out of the soil, or the lateral roots may be broken and left behind.

218. NATTRASS, R. M. 1937. Annual report of Plant Pathologist for the year 1936. Rep. Dir. Agr. Cyprus 1936:50–56.

Uromyces ciceris-arietini was noted for the first time on chickpea in Cyprus.

219. NEMA, K. G., and M. N. KHARE. 1973. A conspectus of wilt of Bengal gram in Madhya Pradesh. Symposium on wilt problem and breeding for wilt resistance in Bengal gram. September 1973 at Indian Agr. Res. Inst., New Delhi, India. p. 4 (Abstr.)

Chickpea cultivation is greatly threatened by wilt disease. Generally the disease occurs at two phases of growth: (i) early seedling stage and (ii) flowering. Damage has been observed to be up to 61 percent at seedling stage and 43 percent at the flowering stage. All types of Bengal gram; viz., *Deshi*, *Kabuli*, pink, green, and black, irrespective of plant type and seed size, are vulnerable to this disease.

F. oxysporum f. sp. *ciceri*, *Rhizoctonia bataticola*, *R. solani*, *Operculella padwickii*, *Sclerotium rolfsii*, *Sclerotinia sclerotiorum* have been found associated with the wilt in different parts of Madhya Pradesh. In stages of growth the wilting was due to one of the three fungi; viz., *F. oxysporum* f. sp. *ciceri*, *R. bataticola*, or *Sclerotium rolfsii*, but at times mixed infection was noted. At flowering, other fungi were also found associated. *Fusarium* was found in vascular tissues of invaded plants. *Rhizoctonia* caused root rot and *Sclerotium* resulted in collar rot. Association of root-knot was observed recently. Physiological wilting due to deficiency of minor elements has also been observed in this state For a suitable control, it is essential to thoroughly investigate the exact cause of the disease at a particular location.

220. NEMLIENKO, F. E., and A. I. LUKASHEVICH. 1957. Agrotechnical measures against ascochytosis of chickpea (in Russian). Plant Prot., Moscow 4:31–33.

In the Dnepropetrovsk region, U.S.S.R., *Ascochyta rabiei* on chickpea was extremely severe in 1956, sometimes causing 100 percent loss. Experiments at the Sinel'nikovsky Experiment Station showed cultural practices to be more important than chemical treatment for control of the disease. Harvesting should be early, as the disease often develops late in damp weather. K fertilizers were advantageous.

221. NENE, Y. L., and M. V. REDDY. 1976. Preliminary information on chickpea stunt. Tropical Grain Legume Bull. No. 5:31–32.

A disease called chickpea stunt was identified as one of the components of the "wilt complex." Plants are stunted and discolored. The phloem shows brown discoloration. Transmission was possible through the use of *Aphis craccivora*. Mechanical as well as graft transmission attempts were unsuccessful.

222. NIGMANOVA, Mme S. 1962. The biology of the fungus *Ascochyta imperfecta* (in Russian). Uzbek. biol. Zh. 6 (5):39–44.

Inoculation of *A. imperfecta* (*Phoma herbarum* var. *medicaginis*) from lucerne to six species of lucerne, Persian clover (*Trifolium resupinatum*), berseem (*T. alexandrinum*), sweet clover (*Melilotus* sp.), esparcette (*Onobrychis*), red clover, mung bean (*Phaseolus aureus*), bean (*P. vulgaris*), chickpea (*Cicer arietinum*), and pea indicated specialization to *Medicago* spp.

223. NOUR, M. A. 1957. Control of powdery mildew diseases in the Sudan, with special reference to broadbean. Emp. J. Exp. Agr. 25:119–131.

The more important crops attacked by powdery mildew in the Republic of the Sudan include chickpea by *Leveillula taurica*.

224. PADWICK, G. W. 1939. Report of the Imperial Mycologist. Sci. Rep. Agr. Res. Inst., New Delhi, 1937–38:105–112.

In periodical isolations from wilted chickpea plants, a number of isolates of *Fusarium* were obtained, one type being predominant. All types were grown in flasks in a sterilized mixture of dry soil, maize meal, and water; after 3 weeks the mixture was applied to a sterilized soil in layers above and below chickpea seed. In some cases inoculated seeds grew as well as the noninoculated controls, in others the seed failed to germinate, while in the case of the type most generally isolated all plants from inoculated seed wilted and died before they were 6 weeks old. The original fungus was invariably isolated from the dead plants.

225. PADWICK, G. W. 1940. The genus *Fusarium* III. A critical study of the fungus causing wilt of gram (*Cicer arietinum* L.) and of the related species of the subsection *Orthocera*, with special relation to the variability of key characteristics. Indian J. Agr. Sci. 10:241–284.

The fungi causing wilt in chickpea are considered to comprise one variety, for which the name *F. orthoceras* App. & Wollr. var. *ciceri* is proposed.

226. PADWICK, G. W. 1940. Report of the Imperial Mycologist. Sci. Rep. Agr. Res. Inst., New Delhi, 1938–39:103–115.

Pending a decisive outcome of experiments to determine identity of the *Fusarium* causing chickpea wilt, no conclusion can be reached as to its taxonomic status, whether a new species or merely a physiologic race of *F. orthoceras* var. *pisi*. The disease was shown to be closely correlated with high temperatures, and to be equally severe in unsterilized and sterilized soils, indicating the absence of biological antagonism as a controlling factor. Late sowing (coinciding with a fall in temperature) was shown by a replicated field experiment to reduce incidence of the wilt (from 11.5% in the 30 Sep sowing to 0.1 and 0.0% respectively, in those of 21 and 28 Oct).

227. PADWICK, G. W. 1941. Report of the Imperial Mycologist. Sci. Rep. Agr. Res. Inst., New Delhi, 1939–40:94–101.

The *Fusarium* causing chickpea wilt (*F. orthoceras* var. *ciceri*) was shown to survive well in roots and stems, even in apparently healthy-appearing plants growing among diseased chickpea harboring enough fungus to be parasitic on the next season's crop. Farmyard manure hastened disappearance of the fungus. A species of *Trichoderma*, highly antagonistic to the organism in Petri dishes, was useless in the soil and an *Aspergillus* which retarded infection was subsequently ineffective. Of 56 chickpea cultivars tested for wilt resistance, the Imperial Pusa Types 9, 28, and 52 were highly susceptible, I.P. 28 was intermediate, and I.P. 22, 63, 69, and 83 showed no infection. I.P. 78 was not affected in 1939, but had 32 percent infection in the season under review.

228. PADWICK, G. W. 1942. Report of the Imperial Mycologist. Sci. Rep. Agr. Res. Inst., New Delhi, 1940–41:52–56.

The general level of infection in the chickpea wilt (*Fusarium orthoceras* var. *Ciceri*) experiment was less during the past year than in the two previous seasons, but the high degree of

susceptibility of the Imperial Pusa 9, I.P. 26, and I.P. 29 cultivars, with 51, 34, and 66 percent disease, respectively, was confirmed; I.P. 28 again occupying an intermediate position (11%). A well-marked correlation was observed between wilt and subsoil dryness at Karnal and Delhi, while late sowing, as in previous experiments, reduced the incidence of the disease.

229. PADWICK, G. W. 1942. Some problems of control of soil-borne fungal diseases in plants. Anniv. Vol. Royal Bot. Gdn. Calcutta, pp. 213–220.

Following a review of some important contributions to knowledge of antagonism between fungi in relation to the control of soil-borne plant diseases, the writer discusses illustrations from his experience of the complexity of the root-invading microflora.

In the second case, the author and N. Prasad isolated from chickpea what seems an extremely varied collection of *Fusarium* spp., some of which were experimentally capable of causing seed decay, while others were responsible for wilting. (See abstract no. 238).

230. PADWICK, G. W., and P. R. BHAGWAGAR. 1943. Wilt of gram in relation to date of sowing. Indian J. Agr. Sci. 13:289–290.

In experiments at the Imperial Agricultural Research Institute farm, Delhi covering 1938 to 1942, chickpea was sown at weekly intervals from 23 Sep to 28 Oct. The incidence of wilt (*Fusarium orthoceras* var. *ciceri*) decreased, with a corresponding increase in grain yield, when sowing was delayed up to at least mid-October; harvests from later sowings tended to decline. In 1938–39, the percentage of wilt sank from 11.5 percent in the 30 Sep sowing to 1.8 in that of 14 October; yields for the two dates were 814 and 1,354 lb per acre, respectively. In 1939–40 and 1940–41, maximum yields were produced by sowings of 21 and 14 Oct (1,652 and 1,304 lb) respectively, the percentage of wilt falling in the latter year from 20 percent in the first to 3.5 percent in the fourth sowing. In 1941–42, the crop was destroyed by hail, but the amount of wilt sank from 64.5 percent in the 30 Sep sowing to 10.8 and 5.0 percent, respectively, in the plots sown on the last two dates in October.

231. PADWICK, G. W. 1948. Plant Protection and Food Crops of India. I. Plant pests and diseases of rice, wheat, sorghum and gram. Emp. J. Exp. Agr.16:55–64.

The author states that the worst disease of chickpea is wilt, although extent of loss has not been determined. The disease appears to be a complex of several root diseases—*Fusarium, Operculella padwickii, Macrophomina phaseoli*, and a nonparasitic cause.

Chickpea blight (*Ascochyta rabiei*) is described, but no longer considered important because of two progenies (C.62–18, C.12–34) from crosses between resistant F8 and a local type Pb-7.

232. PARK, M. 1939. Report on the work of the Division of Plant Pathology. Adm. Rep. Dir. Agr., Ceylon, 1937, pp. D42–D48.

Among the diseases recorded for the first time in Ceylon was collar and root disease of chickpea caused by *Corticium* sp.

233. PAYAK, M. M. 1962. Natural occurrence of gram rust in uredial stage on *Trigonella polycerata* L. in Simla hills. Curr. Sci. 31:433–434.

From Agric. Res. Inst., Flowerdale, Simla, natural infection of *T. polycerata* by *Uromyces ciceris-arietini* in the Simla hills in 1959 is reported. In inoculation tests, chickpea and the original host were infected; *T. foenumgraecum* and *Lathyrus sativus* were not.

234. PEARL, R. T. 1923. Report of the Mycologist to the Government of the Central Provinces and Berar. Report of Dep. of Agr. Central Provinces and Berar for the year ending 30 June 1922. pp. 19–20.

Chickpea was attacked by an apparently undescribed *Fusarium.*

235. PETRI, L. 1933. Review of phytopathological records observed in 1932 (in Italian). Boll. R. Staz. Pat. Veg., N.S.13:1–73.

Chickpea in the vicinity of Cosenza was appreciably damaged by collar and root rot due to *Rhizoctonia violacea* (*Helicobasidium purpureum*).

236. PLYMEN, F. J. 1933. Reports on the working of the Department of Agriculture of the Central Provinces for the years ending the 31 March 1932 and the 31 March 1933. 40 pp.

The highest yield in 1931–32 was obtained from a chickpea hybrid combining the wilt-(?*Fusarium*) resistant Cawnpore (now Kanpur) type and the best local selection, No. 28. In 1932–33 the Cawnpore and Karachi types maintained wilt-resistant qualities.

237. PRASAD, N. 1939. Studies on the wilt of gram. Assoc. I.A.R.I. thesis, Indian Agr. Res. Inst., New Delhi, India.

238. PRASAD, N., and G. W. PADWICK. 1939. The genus Fusarium II. A species of *Fusarium* as a cause of wilt of gram (*Cicer arietinum* L.). Indian J. Agr. Sci. 9:371–380.

Over 300 isolates of *Fusarium* made from wilted plants of chickpea collected in 1937 and 1938 in Karnal and Delhi, India, were separated into 13 groups according to certain

major characteristics. In three lots of infection tests, in which chickpea seeds were sown in pots with infested sterilized soil, two of the groups appeared to be nonpathogenic, eight caused severe seed rotting, and three caused wilting. On this basis, the authors conclude that apart from a wilt of chickpea due to some physiological disturbance occasioned by soil conditions, wilt may certainly be caused by *Fusarium*. It is also clear that wilted chickpea plants may harbor an extraordinarily wide range of *Fusarium* types, perhaps different species, and these are capable of causing two distinct diseases—a seed rot and a wilt. A morphological study of single-spore cultures of the three wilt-producing types isolated showed that all three are alike in major characters and belong to the subsection *Orthocera*.

239. PUERTA ROMERO, J. 1964. Gram blight: isolation of the fungus *P. rabiei* and the study of gram varieties possibly resistant to it (in Spanish). Boln. Patol. Veg. Ent. Agr., 27:15–52.

This disease causes great losses of chickpea wherever it is grown in Spain. Studies on 18 isolates revealed the conditions most favorable for the fungus. Negro, Pedrosillano, Rubio, and Mulato were the cultivars least affected. Of fungicides tested, zineb (*in vitro*) gave the best inhibition, while captan and a zineb-Cu oxychloride mixture were adequate; Burgundy mixture was not. Preventive treatment with ferbam was, however, superior to curative.

240. QUANTZ. 1953. Studies on a seed-transmissible mosaic virus of the Broad-bean (*Vicia faba*) (in German). Phytopath. Z.20:421–448.

Chickpea was found to be a host of the virus.

241. RADKOV, P. 1970. Susceptibility of some chickpea varieties to *Mycosphaerella rabiei*. Rastit. Zasht. 18(9):22–27.

Of 22 local and foreign chickpea cultivars tested, only 1.5 percent were resistant to *M. rabiei*. Not one was entirely resistant in wet years. Early sowing, close spacing, mineral fertilization, and spraying with Bordeaux and sulphur are recommended to reduce yield losses.

242. RADULESCU, E., E. CAPETTI, E. SCHMIDT, and A. CASSIAN. 1971.Contributions to the study of anthracnosis of chickpea (*Mycosphaerella rabiei* Kov.) (in Romanian). Lucrari Stuntifice 14:311–321.

The disease on chickpea was observed during 1968 and again, more severely in 1969, when weather conditions favored infection. All cultivars tested were susceptible.

243. RAHEJA, P. C., and G. P. DAS. 1949. Analysis of agricultural yields II. Effect of cultural treatments on the incidence of gram wilt, *Fusarium orthoceras* var. *ciceri*. Proc. Indian Sci. Cong. 36:195.

Early wilt occurring within a fortnight after germination was of lower intensity than late wilt appearing in March. Initially, well-grown plants were found to be more susceptible to wilt incidence. Nonwilted plants, compared to wilted ones, tended to make up in growth by a significantly higher rate of relative growth. Incidence of wilt made no difference, in rate or in quantity, of flower production. Incidence of wilt corresponds to the trends of the grain yield relating to the treatments of the dates of sowing and depth of seeding. Interspacing of rows made little difference in this respect.

244. RAHEJA, P. C., and G. P. DAS. 1957. Development studies in crop plants II. Effect of cultural treatments on the incidence of gram wilt. Indian J. Agr. Sci. 27:237–250.

An experiment to study the effect of dates of sowing, spacing between rows of the crop and depth of seeding, conducted to record observations on incidence of wilt (*Fusarium orthoceras* var. *ciceri*), in addition to germination, growth, etc. Early wilt occurred about 10 to 15 days after sowing. Late wilt was observed after 14 Mar (podding stage). Treatments did not affect early wilt, but late wilt was significantly higher when deep sowing (5 inches) was practiced.

245. RAMAKRISHNAN, T. S. 1930. A wilt of zinnia caused by *Sclerotium rolfsii*. Reprinted from Madras Agr. J. Oct. 1930, 9 pp.

When artificially inoculated, the fungus could infect chickpea.

246. RAMAKRISHNAN, T. S. 1947. Studies in the genus *Colletotrichum*-III. Proc. Indian Acad. Sci., Sect. B 15:15–27.

Colletotrichum sp. observed on chickpea was considered to be *C. capsici*.

247. RAMAKRISHNAN, T. S. 1955. Leaf spot disease of turmeric (*Curcuma longa* L.) caused by *Colletotrichum capsici* (Syd.) Butl. & Bisby. Indian Phytopath. 7:111–117.

When artificially inoculated, the fungus could infect chickpea.

248. RAMANUJAM, S. 1973. Wilt as a factor limiting production of Bengal gram in India. Symposium on wilt problem and breeding for wilt resistance in Bengal gram. September 1973 at Indian Agr. Res. Inst., New Delhi, India. pp. 1–2 (Abstr.).

Wilting and drying of chickpeas is a major limiting factor in stabilizing the productivity of this crop.

249. RANGASWAMI, G., and N. N. PRASAD. 1960. A bacterial disease of *Cicer arietinum* L. Indian Phytopath. 12:172–175.

At the Dept. Agr., Annamalai Univ., Madras State, the causal agent of a post-emergence rot of chickpea seedlings was determined as *Xanthomonas cassiae*. The radicle developed water-soaked lesions which turned dark brown, a soft-rot attacked the tissues, and the seedling wilted within 3 to 4 days. *X. cassiae* from chickpea was also pathogenic to *Cassia occidentalis*, but not to a number of other hosts.

250. RANGASWAMI, G., and N. N. PRASAD. 1961. Studies on the survival of plant pathogens added to the soil. I. *Fusarium* spp., and *Xanthomonas cassiae*. Indian Phytopath. 14:83–87.

At Annamalai Univ., Annamalainagar, Madras, *X. cassiae* pathogenic to chickpea was able to maintain itself in sterilized soil but was suppressed in nonsterilized soil. In the latter, the suppression of the bacterium was accompanied by an increase of the fungi and Actinomycetes.

251. REICHERT, I., and E. HELLINGER. 1947. On the occurrence, morphology and parasitism of *Sclerotium bataticola*. Palest. J. Bot., R. Ser. 6:107–147.

Detailed data from studies on *Sclerotium bataticola* carried out in 1927–28. Results of this and subsequent work are now given in light of researches since carried out in various countries. The problem concerned the determination of the parasitic vigor of the various isolates obtained from hosts in Palestine, whether they were all pathogenic to the hosts with which they were associated, and whether they differed in morphology, physiology, or pathogenicity.

The authors consider that the name *Rhizoctonia bataticola* should be discarded. *Macrophomina phaseoli* should be applied solely to strains forming pycnidia only and *S. bataticola* to those forming sclerotia only. Those forming both pycnidia and sclerotia should be referred to as *Macrophomina* (*Sclerotium*) *phaseoli*. From Palestine, 118 host plants have been recorded; 132 are recorded for other countries. The geographical distribution of the disease indicates its dependence on ecological factors, chiefly high temperature and humidity.

A comparative study of the morphology of isolates from bean (*Phaseolus vulgaris*), eggplant, potato, pepper, chickpea, tomato, pumpkin, sesame, tobacco, and cotton produced coarse, persistent, aerial mycelium with abundant barrel-shaped cells (dense); and in the sesame isolate, more or less uniformly distributed in concentric zones, but irregularly produced in the cotton and tobacco isolates. The remaining isolates, except that from pumpkin, had a fine collapsing mycelium with a very slight production of dark hyphae and barrel-shaped cells. The pumpkin isolate resembled the latter group in general, but produced relatively more hyphae and barrel-shaped cells.

Five distinct types of sclerotial formation were noted. Type I occurred in all isolates and arose from barrel-shaped cells along a single hypha; type II from two adjacent hyphae; type III from normal cells of a single hypha; type IV from two adjacent hyphae; and type V from barrel-shaped cells of one hypha fusing with normal cells of a second. Type II occurred in bean, potato, chilli, chickpea, tomato, and pumpkin isolates; types III and IV in cotton, tobacco, and sesame isolates; and type V only in the chilli. The 10 isolates did not differ conspicuously in sclerotial size or in their mycelial features; the sclerotia were, however, roundish and smooth in bean, eggplant, potato, chilli, chickpea, tomato, and pumpkin isolates and more or less irregular in the cotton, tobacco, and sesame isolates. When the 10 isolates were grown on potato wedges above water, the sesame isolate gave a deep-yellow color to the liquid distinct from the color produced by the other isolates (pinkish or yellowish) except perhaps that from chickpea, which was a less intense yellow.

252. RETIG, B., and J. TOBOLSKY. 1967. A trial for the control of *Ascochyta* in chickpeas. First Israel Congr. Pl. Path.:50–51.

Six to eight applications of maneb were found effective in significantly reducing the incidence.

253. RHIND, D. 1926. Annual Report of the Mycologist, Burma, for the year ended the 30 June, 1925, Rangoon.

A number of fungi, chiefly species of *Fusarium*, have been isolated from wilted chickpea but inoculation experiments with these organisms, as also with *S. rolfsii*, gave negative results. It is considered doubtful whether the disease is primarily due to fungi.

254. SAKSENA, H. K., and R. PRASADA. 1956. Studies in gram rust, *Uromyces ciceris-arietini* (Grogn.). Jacz. Indian Phytopath. 8:94–98.

Studies at the Indian Agricultural Research Institute, New Delhi, show that chickpea rust (*Uromyces ciceris-arietini*) does not oversummer in the uredostage in the plains, but may do so in the hills, where *Trigonella polycerata*, widespread up to 6,000 ft, was shown by cross-inoculation tests to be a collateral host. Dissemination probably occurs from the hills to the plains, where there is apparently no local source of infection.

255. SARAF, C. S. 1974. Agronomic management technology to reduce gram wilt incidence. Indian J. Genet. & Plant Breeding 34:263–266.

Chickpea wilt has been a serious threat to the cultivation of chickpea. Two schools of thought as to the cause of the disease exist—one states that a fungus *Fusarium orthoceras* f. sp. *ciceri* is wholly responsible for the outbreak of the disease, the other

states that development of this disease is dependent upon certain environmental factors, such as temperature and soil moisture. Agronomic manipulations and lines of future work have been suggested.

256. SAREJANNI, J. A. 1939. Annotated list of the fungi encountered on cultivated plants in Greece (in French). Ann. Inst. Phytopath. Benaki 3(2):41–66.

Ascochyta rabiei is a very troublesome parasite of chickpeas in the vicinity of Lania and Thebes, in Crete, and elsewhere.

257. SAREJANNI, J. A., S. D. DEMETRIADES, and D. G. ZACHOS, 1952. Brief report on the principal plant diseases observed in Greece during the year 1951 (in French). Ann. Inst. Phytopath. Benaki 6(1):5–9.

Chickpeas in Chalcidice are affected by *Ascochyta rabiei*.

258. SATTAR, A. 1933. On the occurrence, perpetuation and control of gram (*Cicer arietinum* L.) blight caused by *Ascochyta rabiei* (Pass.) Labrousse, with special reference to Indian conditions. Ann. Appl. Biol. 20:612–632.

An account of results obtained so far in the investigation, started in 1922, of the destructive blight of chickpea caused by *Ascochyta rabiei*, particularly in the north of the Punjab. The disease is most prevalent and destructive in regions with rainfall of 6 inches and over during the period from October to April when the crop is on the land, annually killing some 50 percent of the plants; when rainfall during this period is less than 6 but more than 3.5 inches annual losses are estimated at roughly 25 percent, while in drier areas the blight occurs rarely and does not cause appreciable injury. In the three districts of Attock, Rawalpindi, and Jhelum alone, annual losses are estimated to amount to a million rupees.

Susceptibility of the plants was found to increase with age, being greatest at the flowering and fruiting stages from February to April, at which time the plant excretes the largest amount of malic acid from the glandular hairs on its surface. Germination of the pycnospores is favored by the presence of malic or tartaric acid or of acidified carbon (Glucose) nutrients (pH 2.5). In testing resistance of chickpea varieties to blight, inoculations should be made at the flowering and fruiting stages; otherwise even susceptible cultivars may show a deceptive appearance of resistance.

Though the fungus is carried inside seed from diseased plants, the chief mode of transmission from year to year is through seed superficially contaminated with spores during threshing; experiments having shown that 50 percent of such spores germinated after 5 months storage at temperatures from 25° to 30°C, and 5 percent survived the same period of storage at 35°. Plants raised from seed smeared before sowing with spores of *A. rabiei* were attacked to the extent of 60 to 100 percent. Infected plant material admixed in the seed was also shown to be an important source of infection, but definite conclusions in regard to the part played by soil infection in the perpetuation of the disease could not be made.

The author considers that the disease could be best controlled by the use of clean seed from disease-free districts, disinfecting contaminated seed in 0.5% copper sulphate solution for 10 minutes, and treating internally infected seed by presoaking in water at 20°C for 6 hours, and then dipping it in hot water at 53° for 15 minutes. In preliminary tests, artificially infected chickpea seeds dusted with malic acid before sowing germinated normally, but all seedlings died off from severe infection when 1 to 1-1/2 inches tall. This suggests a method – deep planting – for preventing seedlings from infected seeds from emerging. A system of crop rotation and the removal of all refuse of the preceding crop are also recommended.

259. SATTAR, A. 1934. A comparative study of the fungi associated with blight diseases of certain cultivated leguminous plants. Trans. Brit. Mycol. Soc. 18:276–301.

Detailed account of the author's investigation of several fungi associated with diseases of cultivated leguminous plants, including chickpeas. A fungus from stem and pod lesions of chickpea in the Punjab was identified as *Phyllosticta rabiei*.

260. SATTAR, A., and A. HAFIZ. 1951. A practical method of inoculating gram (*Ascochyta rabiei*) on a field scale. Proc. Third Pakistan Sci. Conf. pp. 1–2.

For field inoculations, small bits of blighted gram plants are carefully broadcast on the standing crop after ensuring that the stalks of debris carry plenty of viable pycnidia. Infection occurred after rain, even if received months after inoculation. The method is as efficient as the spore suspension spray method. Dried culture of the fungus was as good as plant debris.

261. SATTAR, A., and A. HAFIZ. 1952. A new disease of gram crops in the Punjab. Proc. Fourth Pakistan Sci. Conf. pp. 21–22.

A new disease characterized by stunting of plants, smalling of leaves, and yellowing has been described from Cambellpur, Pakistan. Affected plants seldom bear flowers or pods. Sap inoculations have been sometimes successful. Soil factor has not been ruled out.

262. SATTAR, A., A. G. ARIF, and M. MOHY-UD-DIN. 1953. Effect of soil temperature and moisture on the incidence of gram wilt. Pakistan J. Scientific Res. 5:16–21.

Chickpea wilt (*Fusarium orthoceras* f. sp. *ciceri*) is a serious disease in West Pakistan, causing annual damage of about 12 million rupees. Study of the effect of soil temperature and moisture on

the incidence of the disease in Punjab shows attack of wilt is more rapid at 95°F. When the soil moisture was 9, 12.8, and 24.1 percent, wilting was abrupt and seedlings died within 15 days, while at 16.7 and 18.4 percent the time required for wilting was longer.

263. SAVULESCU, T. 1932. Phytosanitary conditions in Rumania during the year 1930–31 (in Romanian). Inst. Cerc. Agron. al Romaniei Publ. 8, 31 pp.

Anthracnose of chickpeas (*Ascochyta rabiei*), hitherto recorded only in the province of Braila, spread to new areas—presumably by means of infected seed.

264. SAVULESCU, T., C. SANDUVILLE, T. RAYSS, and V. ALEXANDRI. 1934. Phytosanitary conditions in Rumania during the year 1932–33 (in Romanian). Inst. Cerc. Agron. al Romaniei 12,93 pp.

Chickpea anthracnose (*Ascochyta rabiei*) was present in practically every district where this host is grown.

265. SCHARIF, G., E. NIEMANN, and M. GHANEA. 1967. Chickpea blight in Iran *Mycosphaerella rabiei* Kovacevski = *Ascochyta rabiei* (Pass.) Labrousse. Entomologie Phytopath. Appl. 25:9–15.

Biological investigations of *M. rabiei* and seed dressing and fungicide spray trials. In a search for resistant cultivars, two exotic lines, instead of local stock, were considered suitable for propagation.

266. SEN GUPTA, P.K., and C. R. DAS. 1964. Effect of vitamins, hormones, and trace elements on growth and sporulation of *Stemphylium sarcinaeforme*, causal organism of leaf spot of gram. Plant Dis. Reptr. 48:37–40.

Mycelial growth of *S. sarciniforme* from chickpea was increased by thiamine, riboflavin, and panothenin, the more so when in combination, and to maximum by the vitamin B complex. All hormones tested, Except 2,4-D, were inhibitory. All trace elements, except Cu and Zn, stimulated growth, especially in combination.

267. SEN GUPTA, P. K., and C. R. DAS. 1970. Studies on some isolates of *Sclerotium rolfsii* Sacc. Z. Pflkrankh. PflSchutz 77:582–584.

Isolates of *S.* (*Corticium*) *rolfsii* from chickpea and other crops in West Bengal showed considerable variation in rate of growth on potato-dextrose-agar and potato-dextrose broth, but not in morphology. In cross-inoculation tests, chickpea was the most susceptible host. Although isolates were most virulent to their appropriate hosts, specialization was not demonstrated conclusively.

268. SEN GUPTA, P. K., and C. R. DAS. 1971. Studies on some isolates of *Sclerotium rolfsii* Sacc. Annls Phytopath. 3:263–266.

Pathogenicity of various isolates of *S.*(*Corticium*) *rolfsii* was tested on potato, groundnut, guava, wheat, and chickpea. Marked variation was demonstrated, the isolates being most virulent to their appropriate hosts, but host specialization was not demonstrated conclusively.

269. SEN GUPTA, P. K. 1974. Diseases of major pulse crops in India. PANS 20:409–415.

Chickpea is affected mainly by wilt (*Fusarium oxysporum* f. sp. *ciceri* Matuo and Sato), blight (*Mycosphaerella pinodes* B. and Blox), and rust [*Uromyces ciceris-arietini* (Grogn.) Jacz. & Boy.].

270. SEVERIN, H. H. P., and C. F. HENDERSON. 1928. Some host plants of curly top. Hilgardia 3:339–384.

Successful inoculation experiments were carried out with sugarbeet curly top on a number of hosts, including chickpea.

271. SHAIKH, M. H. 1974. Studies on wilt of gram (*Cicer arietinum* L.) caused by *Fusarium oxysporum* f. *ciceri* in Marathwada region. M.Sc. (Ag.) thesis, Marathwada Krishi Vidyapeeth, Parbhani, India.

Chickpea wilt is a complex disease caused by various factors: (i) relative high temperature, (ii) drought conditions, (iii) physiological disturbances in plant metabolism due to soil conditions, and (iv) parasitic agents. In the present study, attention is focused on chickpea wilt caused by *Fusarium oxysporum* f. *ciceri*. Various aspects – (i) incidence of disease, (ii) isolation and identification of pathogen, (iii) pathogenicity of the organism, (iv) cultivar resistance, (v) physiology of *Fusarium oxysporum* f. *ciceri*, and (vi) control measures against wilt – were studied.

In all, 154 isolates of *Fusarium* spp. were obtained from 350 samples of wilted chickpea plants collected from different localities. Mortality of chickpea cultivars due to wilt varied between 1.9 to 7.0 percent under natural conditions at Agricultural Research Station, Badnapur. Varieties BG-2, JEC-1, G.62-404, and BG-109-1 were free from *Fusarium* infection under natural condition.

It was observed that: (i) incidence of wilt disease was more when seeds were sown at the depth of 10 cm, (ii) incidence of wilt was more when higher seed rates were used, (iii) intensity of wilt diseases increased when the plots were irrigated. Different synthetic and nonsynthetic media had profound influence on cultural and morphological character of the

fungus. The pathogen tolerated wide range of pH, with an optimum of between 5.0 to 6.5. The fungus utilized all nitrate sources satisfactorily. Chemical treatment of seeds reduced the wilt disease of gram.

272. SHANKHLA, G. S. 1950. Multiple factor experiment, spacings × depths × dates on the incidence of gram wilt. Assoc. I.A.R.I. thesis, Indian Agr. Res. Inst., New Delhi, India, 89 pp.

273. SHARMA, H. C., and M. N. KHARE. 1969. Studies on wilt of Bengal gram (*Cicer arietinum* L.) at Jabalpur I. JNKVV Research Journal 3:122–123.

Isolations from wilted plants of 24 cultivars yielded *Fusarium orthoceras* and *Rhizoctonia bataticola* in pure cultures. *Fusarium* was associated with the disease in all cultivars except C-235. *Rhizoctonia* was found in 13 cultivars. Wilted plants of C-235 yielded only *Rhizoctonia*.

274. SHAW, F. J. F., and S. L. AJREKAR. 1915. The genus *Rhizoctonia* in India. Mem. Dep. Agric. India Bot. Ser. 7(4):177.

Rhizoctonia napi attacking chickpea among other crops transferred to *Sclerotinia* sp. (*Botrytis cinerea*).

275. SHUKLA, D. S. 1970. Studies on gram wilt caused by *Ozonium texanum* (Neal & Wester) var. *parasiticum* Thirum. Ph.D. thesis, Bhagalpur Univ., Bhagalpur, Bihar.

276. SHUKLA, D. S., and A. P. MISRA. 1970. Pathogenicity of *Ozonium texanum* Neal & Wester var. *parasiticum* Thirum. to different varieties of gram (*Cicer arietinum* L.). J. Appl. Sci. 2(1):51–54.

Not one of the 35 cultivars tested was immune. ST_4, T87, and G2 showed minimum (37.5%); KB, K_3, and K_4 maximum (75%) susceptibility.

277. SHUKLA, D. S. 1972. Effect of soil application of lime and phosphorus on the development of Ozonium wilt of gram. J. Bihar Bot. Soc. 1(1/2):5–11.

Addition of 2000 μg/ml lime to inoculated soil in pots reduced total seedling mortality caused by *O. texanum* var. *parasiticum* on chickpea from 87.5 to 12.5 per cent. Adding 250 μg/ml phosphate reduced the mortality rate to 59.37 per cent; 50 μg/ml reduced it to 84.38 percent.

278. SHUKLA, D. S., and A. P. MISRA. 1972. Effect of soil application of fungicides on inactivation of sclerotia of *Ozonium texanum* var. *parasiticum* and incidence of gram wilt. Indian Phytopath. 25:378–386.

In tests on chickpea, 14 fungicides were incorporated in inoculated sterilized soil in glass tubes and pots. As powders, Agrosan GN, Ceresan, and PCNB (quintozene) at 400 μg/ml killed sclerotia to a depth of 4 cm. Mercuric chloride was equally effective at 3000 μg/ml. Seedling wilt was not observed when the soil was treated with fungicides at these concs. As soil drenches, mercuric chloride was effective against the sclerotia at 1250 μg/ml, formalin at 8000 μg/ml, and quintozene at 10,000 μg/ml. Mercuric chloride checked the disease at 1250 μg/ml and formalin at 10,000 μg/ml.

279. SHUKLA, D. S. 1974. Influence of seed and root exudates on germination of sclerotia of *Ozonium texanum* var. *parasiticum*, the incitant of gram wilt, and effect of mixed cropping in relation to the wilt development. Indian Phytopath. 27:97–100.

Germination of sclerotia was 100 percent in distilled water and in seed and root exudates of chickpea, wheat, and barley, but was completely inhibited in 75 to 100% concs. of seed and root exudates of mustard. Sclerotia in direct association with chickpea, wheat, and barley roots 24 to 48 hours of age germinated well, but did not germinate with mustard roots of the same age. Pre- and postemergent death of chickpea when raised as a single crop in infested soil were 30 and 47.5 percent respectively. Death decreased to 7.5 and 20 percent, respectively, when chickpea was grown in association with mustard. Mustard plants were not infected.

280. SIDDIQI, M. A. 1971. Report Senior Plant Pathologist, Malawi, 1969–70, 10 pp (cyclostyled).

Amongst new records is that of *Uromyces ciceris-arietini* on chickpea.

281. SINGH, D. 1976. Effect of soil amendments on some soilborne pathogens of gram. Thesis submitted to the J. N. Agricultural University, Jabalpur for degree of M.Sc.(Ag.). 56 pp.

Effect of soil amendments with residues of five crops on three pathogens, i.e., *Sclerotium rolfsii*, *Rhizoctonia bataticola*, and *Fusarium oxysporum* f. sp. *ciceri* and their host chickpea. A considerable inhibition in growth of radicle of chickpea was observed with the extract of soil amended with mature crop residues of wheat, oats, chickpea, pea, and lentil. Extracts of soil amended with immature chickpea, pea, and lentil crop residue significantly inhibited growth of *S. rolfsii*. On the other hand, its growth was significantly stimulated with extract of mature wheat, oats, chickpea, lentil, or immature oats. In pot experiments, amendments with all the mature crops were

ineffective in reducing intensity of the disease. Significant inhibition in growth of *R. bataticola* was observed with the extracts of soil, amended with immature and mature crop residues of wheat, chickpea, pea, and lentil. Growth of the pathogen significantly stimulated in case of extract of soil amended with crop residue of immature oats. Population of the pathogen in soil amended with mature wheat and oat crops decreased with time. Significantly less percentage in infection was also found in soil amended with mature wheat and oats crops respectively.

Growth of the pathogen, *F. oxysporum* f. sp. *ciceri*, was significantly inhibited with immature and mature wheat, oats, chickpea, pea, and lentil crop residues. However, the decrease in population and reduction in infection were nonsignificant.

282. SINGH, D. V., A. N. MISRA, and S. N. SINGH. 1974. Sources of resistance to gram wilt and breeding for wilt resistance in Bengal gram in U.P. Indian J. Genet. & Plant Breeding 34:239–241.

The problem of chickpea wilt is complex. Species of *Fusarium* (*F. orthoceras* f. sp. *ciceri* and *F. solani*) have been shown to be the main cause of chickpea wilt. Occasionally *Ozonium texanum* has also been stated to cause this disease. Symptoms produced by various root-rotting fungi; viz., *Rhizoctonia bataticola, R. solani, Sclerotium rolfsii, Sclerotinia* sp., and *Operculella padwickii* on chickpea overlap with one another and are often confused with wilt symptoms.

Studies carried out at Kanpur, Uttar Pradesh revealed that *F. orthoceras* f. sp. *ciceri* is the main cause of chickpea wilt in U.P. As a result of work done during the last two decades, some sources of resistance to chickpea wilt (*F. orthoceras* f. sp. *ciceri*) (viz., 88, 93, 100, 101, 106, 4313–2–93, P–315, P–1231, 206, P–692, and P–1663) were identified.

Of the above sources, three lines – 100, 101, and 106 – were used in the hybridization program with T-2 and T-3 as agronomic base. Crosses amongst the wilt-resistant donors were also attempted in order to build up wilt resistance. In F_5, of 10 cross combinations 24 resistant selections were obtained during 1972–73. Two of these – 32/35-8/7 and 32/35-32/2 – obtained from the cross 100 × 106 seem to be promising.

283. SINGH, D. V., S. LAL, and S. N. SINGH. 1974. Breeding gram (*Cicer arietinum* L.) for resistance to wilt. Indian J. Genet. & Plant Breeding 34:267–270.

Wilt causes tremendous loss in yield. At U.P. Institute of Agricultural Sciences, Kanpur, a wilt-sick nursery has been developed and efforts made to screen germplasm for resistance and breed resistant cultivars. As a result of rigorous screening 26 cultivars of chickpea were found resistant where mortality due to wilt was recorded only up to 5 percent.

Four cultivars – viz 100, 101, 106, and 6002 – found to be resistant to this disease about 6 years ago were used in the crossing program. Six crosses between the wilt-resistant cultivars and recommended cultivars (100 × T-1, 100 × T-2, 100 × T-3, 101 × T-3, 106 × T-3, and 6002 × T-3) and two crosses (100 × 101 and 100 × 106) between resistant types were made during 1967–68. Pedigree method of breeding was followed. Of 357 progenies in F_4 generation, 53 were found to be resistant; mortality approached 5 percent. Of these resistant types, 10 were promising for yield and other agronomic characters. One progeny, viz 315 from the cross 100 × 106, was found quite uniform and is a recommended cultivar of the Institute.

284. SINGH, G., and P. S. BEDI, 1974. The relative reaction of different varieties of gram (*Cicer arietinum* L.) to foot-blight caused by *Operculella padwickii* Kheswalla. J. Res., Punjab Agr. Univ. 11:400–402.

Of 53 cultivars tested in an infested plot at Gurdaspur, none was immune from the disease. G 543 was resistant with 3.1 percent infection in 1971–72 and 4.8 percent in 1972–73.

285. SINGH, G., and P. S. BEDI. 1975. The perpetuation of *Operculella padwickii*, the cause of foot blight (rot) of gram in the Punjab. Indian Phytopath. 28:546–548.

The fungus can survive from one season to the next in diseased plant debris; better when stored with farm yard manure. It survives in plant debris left on the soil surface or buried at depths up to 15 cm.

286. SINGH, K. B., and B. S. DAHIYA. 1973. Breeding for wilt resistance in chickpea. Symposium on wilt problem and breeding for wilt resistance in Bengal gram. September 1973 at Indian Agr. Res. Inst., New Delhi, India, pp. 13–14 (Abstr.).

Rough estimate indicates about 10 percent loss due to wilt in practically all chickpea-growing states. Loss is sometimes 100 percent. Genetic control of Fusarium wilt seems to be the most practical means of controlling the disease. The major bottleneck in breeding wilt resistant cultivars has been the non-availability of suitable donor parent, i.e., free or resistant cultivars. Some old cultivars, known to carry resistant genes, have become susceptible. Cultivar G 543, found to be resistant under field conditions in Punjab, could be used as a donor parent. Need for locating reliable resistance sources has been emphasized.

287. SINGH, L. 1973. The problem of wilt and breeding for wilt resistance in Bengal gram. Symposium of wilt problem and breeding for wilt resistance in Bengal gram. September 1973 at Indian Agr. Res. Inst., New Delhi, India. p. 15 (Abstr.).

Wilting in chickpea is widely observed from seedling to podding stage. The causes are of a complex physiologic and pathogenic nature, being affected considerably by soil and moisture conditions during the growing period. The soil-borne *Fusarium* sp., along with some other genera such as *Rhizoctonia*

and *Operculella,* have been ascribed to cause wilt. These factors complicate the approach to breeding for resistance to wilt. Breeding approaches include development of suitable wilt-sick plot for artificial screening of genetic stock and segregating populations, study and control of environmental factors affecting disease, and identification and utilization of suitable donors for resistance.

288. SINGH, L. 1974. Breeding for wilt resistance in Bengal gram. Indian J. Genet. & Plant Breeding 34:247–250.

Methodology to breed wilt-resistant varieties is suggested.

289. SINGH, R. D. 1927. Annual Report of the Cerealist to Government, Punjab, Lyallpur, for the year ending 30th June 1926. Rept. on the Operations of the Dept. of Agr., Punjab for the year ending 30 June 1926, Part II (I):1–45.

Heavy damage to the chickpea crop in a number of places in the Attock district has been caused during the last 2 years by blight (*Mycosphaerella pinodes*) which causes a brownish spotting of the shoots, stems, and pods and often kills the plants. Late cultivars, e.g. Rajanpur, Alipur, Punjab No. 23, and Khanewal, suffered severely in the Bariar experimental crop, while Punjab No. 7, Bhakkar, Isakhel, and Mianwali were resistant. Further experiments in cultivar selection are in progress. In the meanwhile, control measures should include the use of healthy seed from noninfected localities, burning of diseased material, and a 3 to 4 years' crop rotation.

290. SINHA, S. 1973. Some factors of the soil in relation to Fusarium wilt of Bengal gram (*Cicer arietinum* L.). Symposium on wilt problem and breeding for wilt resistance in Bengal gram. September 1973 at Indian Agr. Res. Inst., New Delhi, India, pp. 9–11 (Abstr.).

Fusarium oxysporum f. sp. *ciceri* is the main organism in the causation of wilt of chickpea, although a few other fungi are associated with the disease. The wilt is noticed as early as late December around Agra and most of the northern tracts when the crop is in seedling stage. The seedlings, if attacked, die and dry out soon. Those which are not affected remain apparently healthy throughout January. But in February, usually by the third week, the disease spreads. Affected plants may (i) wilt entirely after flowering, (ii) show partial wilting in which half the plants wilt in early stages and the rest remain healthy, producing pods and seeds, (iii) show partial wilting in which half of the plant keeps healthy throughout and the remaining part wilts after flowering stage mostly without producing seeds.

Pot experiments revealed that soil pH (8.4–9.2) significantly reduces the wilt without adversely affecting shoot dry weight, seed yield, seed number, and pod number. Lower levels of soil moisture (10%) keeps mortality down, though 12 percent of the plants were damaged, as compared to 83 percent in soil with moisture at 25 percent level. Amendments of soil with oil-cakes of groundnut, sesame, and mustard reduced percent mortality from 63 percent in control to 21, 18, and 8 percent respectively. Study of soil temperature relations showed that the disease is optimum at 25°C and is at low ebb at 20°C. Early maturing cultivars may be sought, as the disease spreads extensively when the day temperature rises.

Sclerotium rolfsii is another organism associated with the wilt. Laboratory/glasshouse experiments revealed that the disease is favored at 30°C soil temperature. Alkaline soil (pH 9.2) keeps down mortality; the disease is favored by low moisture content (10%). Additions of compost reduce mortality. The disease is less severe in light or heavy soil than in loamy soil. An unmanured acidic soil low in moisture gave high mortality, whereas a manured-alkaline soil high in moisture reduced mortality to 30 percent. Mortality in control was 90 percent.

291. SINHA, S., and P. BAHADUR. 1974. Phyllosphere mycoorganisms of gram in relation to *Uromyces ciceris-arietini* and disease incidence. Indian Phytopath. 27:271–277.

Leaf-surface mycoorganisms have recently been found to influence leaf infections by stimulating or inhibiting spore germination of pathogens. In this investigation, 38 fungi occurring on the leaf-surface of chickpea during February and March (when rust infection occurs in the Agra area) were screened for antagonistic effect, if any, on germination of uredospores of *Uromyces ciceris-arietini,* the causal agent of rust of chickpea. The population/sq cm abundance and frequency during the first, second, and third week after initiating the experiment were determined.

When uredospores were germinated in the supernatant of a 48-hr spore suspension of leaf-surface organisms, significant inhibition in uredospore germination was observed in some cases – e.g. in the spore suspension of *Chaetomium globosum, Trichoderma koningi, Malustela aeria, Fusarium orthoceras,* and *Fusarium oxysporum.* When spores of these organisms were mixed with uredospores of the rust in the ratio of 2:1, 1:1, and 1:2 and the mixture inoculated on host plant there was significant reduction in the number of rust pustules formed as compared to control plants, which were inoculated with uredospores only. It is suggested that some inhibitory substance/s are produced by some of the phyllosphere fungi and there is scope for biological/chemical control of the rust. In most cases the antibiotic property of the supernatant of the spore suspension was thermostable.

292. SKOTLAND, C. B., and D. W. BURKE. 1960. A virus of wide host range seed-borne in *Phaseolus vulgaris.* Phytopathology 50:655.

Some 2 to 3 percent of seed from a field of Columbia Pinto beans resistant to bean viruses 1 and 1A (bean common mosaic virus strains) produced virus-infected plants with symptoms similar to bean common mosaic. Infection did not protect against bean common mosaic virus or virus 2 (bean yellow mosaic virus). The dilution end-point was 1:10,000–1:50,000,

survival *in vitro* 72–96 hr at 18°C and thermal death point 65 to 75° for 10 min. The virus infected *P. lunatus, P. acutifolius* var. *latifolius*, cowpea, and chickpea. Systemic infection (leaf mottle, stunting, and necrosis) was noted. Susceptible bean cultivars included Great Northern U. of I.123, Early Pink, Blue Lake, Improved Tendergreen, Black Valentine, and Keeney Refugee, while Topcrop, Idaho Bountiful, and Idaho Refugee were immune.

293. SNYDER, W. C., A. O. PAULUS, and A. H. GOLD. 1956. Virus yellows of garbanzo. Phytopathology 46:27 (Abstr.).

Field plants of chickpea in San Diego, Ventura, Santa Barbara, Yolo, and Alameda counties of California frequently are affected by a yellows disease. As many as 50 percent of the plants may be infected. The amount of yellows varies with the season, but the disease has been observed in California since 1937. Symptoms consist of a general yellowing of foliage, shortening of internodes, often an increased stiffness and twisting of the terminal growth, and brown internal vascular discoloration of the stem. Discoloration is confined largely to the phloem and is usually sterile. Early infection may result in death of the plant. Electron microscopy has revealed the presence of rods, resembling those of yellow bean mosaic virus, concentrated in the discolored phloem tissues. Juice transmissions have yielded strains of yellow bean mosaic virus, and occasionally, other viruses.

294. SOLEL, Z., and J. KOSTRINSKI. 1964. The control of *Ascochyta anthracnose* of chickpea. Phytopath. Mediterranea 3:119–120.

A. rabiei began to spread in test plots of chickpea in mid-February reaching a maximum in mid-March. The "Bulgarian" var. was immune. Effective control was obtained and yield increased by six sprays with zidan 65 (65% zineb) at 3 kg/200 l water/ha. Phytotoxicity was not observed. Germination was unaffected and a considerable increase in yield was obtained after spraying.

295. SONDHI, J. K. 1965. Rhizosphere studies in relation to Fusarium wilt of gram, *Cicer arietinum* L. Ph.D. thesis. Agra Univ., Agra, India.

296. SORAN, H. 1975. The most important diseases of chickpea in Central Anatolia (in German). J. Turkish Phytopath. 4(2):53–62.

This paper was presented at the First Plant Pathological Congress at Izmir, Oct 1975. *Ascochyta rabiei, Pythium ultimum, Fusarium oxysporum* and *F. acuminatum* (*Gibberella acuminata*) were isolated from soil samples and diseased chickpea plants. *A. rabiei* was strongly pathogenic. The pathogenicity of the *Pythium* isolates varied between 7 and 100 percent and that of *Fusarium* isolates between 0 and 50 percent.

297. SPRAGUE, R. 1929. Host range and life-history studies of some leguminous *Ascochytae*. Phytopathology 19:917–932.

Mycosphaerella pinodes was found capable of attacking a wide range of hosts, often in a virulent manner, under the conditions of these experiments. *Vigna sinensis*, chickpea, and *Lupinus polyphyllus* proved susceptible both to *M. pinodes* and *A. pinodella*.

298. SPRAGUE, R. 1930. Notes on *Phyllosticta rabiei* on chickpea. Phytopathology 20:591–593.

Examination of material and cultures supplied by D. Atanasoff from Bulgaria confirmed that the common disease of chickpea, caused by *Phyllosticta rabiei*, is distinct from any *Ascochyta* on legumes. About 5 percent of the total number of spores in the French and Italian collections and inoculated plants examined were found to be bicellular by means of a faint septum. Mature aerial lesions produced on legumes by *P. rabiei, Mycosphaerella pinodes*, and *A. pisi* were compared. *P. rabiei* forms mottled brown to deep tan lesions, with two to three wide concentric bands and vague to prominent red margins; the pycnidia are very obscure. Lesions produced by *M. pinodes* are dark-brown, with numerous zonations, ill-defined margins, and obscure pycnidia. *A. pisi* forms pale tan, nonzonate lesions with prominent red-brown margins and conspicuous pycnidia. The cultural characters of *P. rabiei, A. pisi*, and *M. pinodes* (briefly described) differ in important particulars. Young plants of garden pea, *Vicia villosa, Lathyrus odoralus, Dolichos lablab, Lens ervum*, and bean (*Phaseolus vulgaris*) sprayed with aqueous spore suspension of *P. rabiei* showed no infection, but chickpeas similarly inoculated were practically destroyed within a very short time. Pycnidia developed in great profusion. This virulent blighting is of the same type as that occurring in Europe, where it has been long known. Doubtful results were given by the inoculation of chickpeas with *A. pisi* and *M. pinodes*. The latter fungus, however, was shown in the writer's previous investigations to be capable of causing severe foot rot of chickpeas.

In its morphological and pathogenic characters, *P. rabiei* somewhat resembles *M. pinodes*. The two fungi differ, however, in their incubation periods, degree of virulence on the aerial parts of the hosts, nature of symptoms, cultural characters, absence of a perfect stage, and almost complete lack of septation in the spores of *P. rabiei*. The position of the chickpea fungus in the genus *Phyllosticta* is held to be somewhat less definite than that assumed by Trotter. Both are agreed, however, as to the possibility of a past genetic connection with *Ascochyta*. It is apparent that the chickpea disease caused by *P. rabiei* must be treated as a problem distinct from that of infection by *A. pisi* and *M. pinodes*.

299. SPRAGUE, R. 1932. Notes on *Phyllosticta rabiei* on chickpea. II. Phytopathology 22:786–787.

The author does not approve of Labrousse's proposal to transfer the causal organisms of chickpea anthracnose from *Phyllosticta* to *Ascochyta* as *A. rabiei* (Pass.) nov. comb. on account of its sometimes septate conidia and occurrence on organs other than leaves. Though technically justifiable, a rigid adherence to these as generic characters would cause much confusion in several analogous cases, briefly discussed. The writer cannot follow Labrousse in considering *A. pinodella* L. K. Jones as a parallel case to *P. rabiei*, since collections of the former show septation in nearly 100 percent of the spores, whereas in the latter 96 to 98 percent are nonseptate. The retention of the combination *P. rabiei* (Pass.) Trotter is, therefore, advocated.

300. SREEKANTIAH, K. R. 1952. Fungal flora of stored rice, pea and gram seeds, their correlation to seedrotting and pre-emergence injuries and the beneficial effects of fungicidal treatment. Assoc. I.A.R.I. thesis, Indian Agril. Res. Inst., New Delhi, India. 106 pp.

301. STEPANOVA, M. Yu. 1971. Spread of *F. oxysporum* in Legumes (in Russian). Trudy vses Inst. Zashch. Rast. 29:100–105.

An account of the penetration and spread of the pathogen (*Fusarium oxysporum*) in chickpea.

302. SUBBA RAO, N. S. 1973. Etiology of pathological wilting in plants. Symposium on wilt problem and breeding for wilt resistance in Bengal gram. September 1973 at Indian Agr. Res. Inst., New Delhi, India, p. 3 (Abstr.).

The etiology of chickpea wilt is not as well understood as that of wilts of other plants caused by *Fusarium* or *Verticillium*. Therefore the primary task is to clearly understand the *modus operandi* of chickpea wilt in detail as part of efforts to control the disease.

303. SUHAG, L. S. 1973. Mycoflora of gram (*Cicer arietinum*) seeds: pathology and control. Indian J. Mycol. & Plant Path. 3:40–43.

Of the fungi isolated, three caused pre- and post-emergence rot. Best control was given by Agrosan GN, Agallol, captan, and thiram.

304. SUNDARARAMAN, S. 1927. Some vermicularias of economic importance in south India. Madras Agr. Dept. Year Book 1926, pp. 10–12.

A *Vermicularia* sp. on chickpea has been recorded and described. *Vermicularia* sp. on chickpea possesses concentric, subdivided, superficial pycnidia, 50 to 80 by 6 to 9 μ, and unicellular, hyaline spores measuring 21 to 34 by 3 to 6 μ.

305. SURYANARAYANA, D., and S. R. PATHAK. 1968. Outbreaks and new records. FAO Plant Prot. Bull. 16 (4):71–74.

Oogonia reported, possibly of *Phytophthora megasperma* (?), in diseased stems of chickpea from the Punjab.

306. TETEREVNIKOVA-BABAYAN, Mme D. N. 1963. On the specific range of diseases of seed legume crops in Armenia (in Russian). Izv. Akad. Nauk Armyan. S.S.R. Biol. Sci. 16 (1):9–21.

Review from the Dept. Bot., Erevan State Univ., of diseases of beans (*Phaseolus* spp.), pea, chickpea, and other legumes, with details on the distribution in Armenia and control measures.

307. THIRUMALACHAR, M. J., and J. N. MISHRA. 1953. Some diseases of economic plants in Bihar, India. I & II. FAO Plant Prot. Bull. 1 (10):145–146, and 2 (1):11–12.

Diseases of economic plants observed in Bihar, India, in 1952–53 included wilt (*Operculella padwickii*) of chickpea not previously recorded in Bihar. Wilt killed nearly 70 percent of the plants. Infection occurred when the pods were setting, and yield was reduced considerably.

308. VASUDEVA, R. S., and H. S. SAHAMBI. 1957. Phyllody diseases transmitted by a species of *Deltocephalus* Burmeister. Proc. IV International Congress of Crop Protection, Hamburg, pp. 359–360.

The causal agent of the sesame phyllody could be transmitted to chickpea by *Deltocephalus* sp. The disease was also seen in fields under natural conditions.

309. VEDYSHEVA, R. G. 1966. Evaluation of the resistance of *Cicer arietinum* to *Ascochyta rabiei* (in Russian). Vest. sel'.-khoz. Nauki, Mosk. 11 (12):109–111.

In trials in 1962–65, none of the specimens tested was immune but some from Kuban', Georgia (U.S.S.R.), Bulgaria (cf. 45, 1589), Moldavia, and Krasnokutsk were highly resistant. Among the hybrids, VIR 32 (obtained by complex crossing), had the highest resistance. Protein content of the seeds fell by 0.03 to 2.3 percent even when incidence was low. Multiple sowing in infested soil often reduced resistance.

310. VEDYSHEVA, R. G. 1966. Infection of chickpea with *Ascochyta rabiei* in infected ground (in Russian). Zap. Voronezh, sel'. -khoz. Inst. 32:275–281.

In preparing the ground for infection under Kuban conditions the debris of infected chickpea may be introduced in autumn as well as in spring. Of 58 samples, only hybrid VIR 32 and K 279 from Georgia showed high resistance.

311. VENKATARAMAN, K. 1959. Phyllody in Bengal gram. Madras Agr. J. 46:97–98.

A new disease characterized by the phyllody of flowers has been described from Coimbatore, India.

312. VERMA, R. K. 1976. Chemotherapeutic activity of five systemic fungicides in gram seedlings against three soilborne pathogens. Thesis submitted to the J. N. Agricultural University, Jabalpur for the degree of M.Sc.(Ag.) Plant Pathology, 78 pp.

Chickpea (cultivar G-62–404) seed treatment with Bavistin or carboxin at the rate of 0.25 percent protected plants in potted soil infested with *Sclerotium rolfsii* or *Fusarium oxysporum* var. *ciceri* or *Rhizoctonia bataticola*. These fungicides, found to absorb and translocate in seedlings, persisted up to 12 days. They were also found to protect seedlings in a field for 30 days or more even though root rot, collar rot, and wilt of chickpea by the above pathogens were known to be apiphytotic each year.

313. VERMA, R. K., and S. C. VYAS. 1976. Uptake, translocation and persistence of five systemic fungicides in gram seedlings. Pesticides 10 (12):21–24.

Studies indicated that carbendazim, benomyl, carboxin, chloroneb, and thiabendazole were fungistatic *in vitro* to *Sclerotium rolfsii*. All were absorbed by roots and translocated to the shoots. Root extracts were more fungitoxic than shoot extracts. The higher the concentration of fungicide and exposure time, more was the uptake in seedlings. Uptake and translocation was high in chickpea seedlings from soil amended with systemic fungicides as compared to seed or root application. Carbendazim persisted more in seedlings as compared to other systemic fungicides. The persistence of fungicides was in the following descending order: carbendazim > chloronel = TBZ > benomyl > carboxin.

314. VIENNOT-BOURGIN, G. 1939. A contribution to the study of the cryptogamic flora of the Seine basin. 14th Note. On two *U. anthyllidis* (Grev.) Schroet. (in French). Rev. Path. Veg. 16:66–92.

Uromyces ciceris-arietini reported on chickpea.

315. VIR, S., and J. S. GREWAL. 1974. Peroxidase activity associated with Ascochyta blight of gram (*Cicer arietinum* L.). Phytopathologia Mediterranea 13:174–175.

Peroxidase activity was more in the extract of leaves irrespective of cultivar or inoculation. In the present study peroxidase levels were similar in stems extract of noninoculated "Pb 7" and "I-13;" however, noninoculated leaves of "I-13" showed slightly higher peroxidase activity than noninoculated leaves of "Pb 7". After inoculation the enzymatic activity increased in leaves and stems of "I-13" and "Pb 7" which was more pronounced in resistant cultivar "I-13." In resistant cultivar "I-13," the enzymatic activity continued to increase from 4 to 12 days after inoculation. However, susceptible cultivar "Pb 7" when inoculated showed increase in enzymatic activity up to the eighth day, then it remained almost constant. The results indicate that peroxidases may play some role in the resistance to blight pathogen.

316. VIR, S., and J. S. GREWAL. 1974. Physiologic specialization in *Ascochyta rabiei* the causal organism of gram blight. Indian Phytopath. 27:355-360.

On the basis of preliminary cultural studies, 268 isolates of *A. rabiei* from different sources could be divided into 13 groups. Based on the disease reaction on differential chickpea cultivars, 13 representative isolates of the fungus were distinguished into five groups. These could be further categorized into two distinct groups on the basis of pathogenicity and growth rate, confirming the existence of two races. The fast-growing isolates (belonging to group 1 and 3) constitute race-1, while the slow growing isolates (belonging to group 2 and 4) constitute race-2. Isolate J-101 (group 5) has been designated a biotype of race-2.

317. VIR, S., and J. S. GREWAL. 1974. Changes in phenolic content of gram plant induced by *Ascochyta rabiei* infection. Indian Phytopath. 27:524–526.

The present study was undertaken to find out the total phenolic contents of chickpea plants before and after inoculation with *Ascochyta rabiei* (Pass.) Lab. Phenolic contents were higher in the leaves than in the stem. There was no significant difference in phenolic contents in resistant (I-13) and susceptible (Pb 7) cultivars before inoculation; after inoculation, increase was more pronounced in the resistant cultivar than in the susceptible one.

318. VIR, S., and J. S. GREWAL. 1974. Evaluation of fungicides for the control of gram blight. Indian Phytopath. 27:641–643.

Captan (1 kg/400 l water) was found effective when sprayed four times. Zineb was next in efficacy.

319. VIR, S., and J. S. GREWAL. 1975. Role of free Amino acids in disease resistance to gram blight. Indian Phytopath. 28:206–208.

Chromatographic analysis of leaves and stems of chickpea for

free amino acids indicated the presence of a higher amount of L-cystine in blight resistant cultivar (I-13) as compared with susceptible cultivar (Pb 7). *In vitro* studies showed that L-cystine had an inhibitory effect on growth and spore germination of *Ascochyta rabiei*, the causal organism of chickpea blight. This inhibitory effect of L-cystine could not be nullified even by addition of higher amount of L-asparagine in the medium.

320. VIR, S., and J. S. GREWAL. 1975. Change in catalase activity of gram plant induced by *Ascochyta rabiei* infection. Indian Phytopath. 28:223–225.

Catalase activity was estimated in leaves and stems of resistant (I-13) and susceptible (Pb 7) cultivars of chickpea inoculated with *Ascochyta rabiei*. Catalase activity increased in inoculated resistant cultivar but decreased slightly in inoculated susceptible cultivar.

321. VIR, S., J. S. GREWAL, and V. P. GUPTA. 1975. Inheritance of resistance to Ascochyta blight in chickpea. Euphytica 24:209–211.

The mode of inheritance of resistance in chickpea to *A. rabiei* isolate G-52 was studied in three cross combinations and their reciprocals. Resistance in cv. I-13 was controlled by a single dominant gene pair.

322. VISHWAKARMA, S. N., and K. C. B. CHAUDHARY. 1974. Floral blight of gram incited by *Alternaria alternata*. Netherlands J. Plant Path. 80:110–112.

A note on the identity of the causal organism of a serious floral blight of chickpea observed in 1970–72 at the Agr. Farm of the University.

323. VYAS, S. C. 1971. Some storage factors influencing persistence to thiram used for treating gram and sorghum seed. Ph.D. thesis submitted to the U.P. Agricultural University, Pantnagar, India. 141 pp.

Comparatively higher quantitative and qualitative losses of thiram when chickpea seed was stored under adverse conditions, such as higher relative humidities and higher temperatures. Treated seed when stored in polythene bags showed less losses and better viability. It is suggested that chickpea seed be treated with rates between 0.3 to 45 percent to compensate for storage losses.

324. VYAS, S. C., and L. K. JOSHI. 1975. A new record of parasitic dodder on chickpea (*Cicer arietinum* L.). Curr. Sci. 44:701–702.

Cuscuta hyalina Roth. was reported to infest chickpea under natural conditions in fields at Raipur (M.P.), India.

325. WALLACE, G. B. 1941. Report of Plant Pathologist. Rep. Coffee Res. Exp. Sta., Lyamungu, Moshi, 1939 (Pamphl. Dept. Agric. Tanganyika 27):17–18.

Uromyces appendiculatus reported on chickpea.

326. WALLACE, G. B. 1948. Annual Report, Department of Agriculture, Tanganyika Territory, 1947. 3 pp.

Ascochyta rabiei caused total loss in some chickpea fields.

327. WESTERLUND, F. V., Jr., R. N. CAMPBELL, and K. A. KIMBLE. 1974. Fungal root rots and wilt of chickpea in California. Phytopathology 64:432–436.

In the central coastal area of California these diseases of chickpea are caused by at least five fungi – *Fusarium oxysporum* f. sp. *ciceri*, *F. solani* f. sp. *pisi*, *Pythium ultimum*, *Rhizoctonia solani* and *Macrophomina phaseoli* (*M. phaseolina*). *F. solani* f. sp. *pisi* and *F. oxysporum* f. sp. *ciceri* cause similar yellowing and wilt, while the former causes distinctive black root lesions and the latter a vascular discoloration extending to the top of the shoot. *F. oxysporum* was found in 6 percent of wilted plants and *F. solani* in 47 percent. Some evidence was obtained that *F. oxysporum* f. sp. *ciceri* requires a wound for efficient infection, but *F. solani* f. sp. *pisi* does not. The latter is seedborne in a low percentage of seeds but the former is not. Virus diseases were not found on chickpea during 1971–72.

328. ZACHOS, D. G. 1951. Studies on the disinfection of chickpea seeds (*Cicer arietinum* L.) infected with *Ascochyta rabiei* (Pass.) Labr. (in French). Ann. Inst. Phytopath. Benaki, 5, 2:76–87.

Anthracnose of chickpea caused by *Ascochyta rabiei* has become endemic in most areas of Greece to the extent that healthy seeds are virtually unobtainable. Experiments on control of this disease were therefore undertaken with badly infected seed from the Plant Improvement Station, Messara, Crete. Seeds were first immersed for 1 minute in 96% alcohol followed by 1 to 2 minutes in 1 in 1,000 mercuric chloride solution, then washed in sterile distilled water before receiving one of several test treatments. They were finally washed to remove all traces of the chemicals, sown on plates of potato-dextrose-agar, incubated at 20° to 21°C, and examined after 8, 15, and 22 days.

Soaking in 5% glacial acetic acid for 1 minute, 1% for 5 minutes, or 0.05% for 4 hours destroyed the parasite in 60, 56.3, and 56 percent of the seeds, respectively. In five tests immersion for 2 hours in 0.005% malachite green gave an average of 84 percent control. Three tests, each of 4 hours in 0.05% formalin

solution (37/41%), gave an average of 93.3 percent control. Immersion for 10 minutes in hot water at 45° to 47° C destroyed the fungus in 85.8 percent of the seeds and in 87.5 percent when the same treatment was preceded by a 3-hour soak in water at 20°. Sattar's hot-water method impeded germination.

It is concluded that formalin and malachite green offer the best prospect of control but the results need to be supplemented by field tests.

329. ZACHOS, D. G. 1952. A case of parasitism of chickpea (*Cicer arietinum* L.) seeds by *Stemphylium botryosum* Wallr. (in French). Ann. Inst. Phytopath. Benaki, 6, 2:60–61.

In a lot of chickpea seeds received from the Plant Improvement Station, Messara, Crete, 27 percent were found to be attacked and prevented from germinating by *Pleospora herbarum*. Of the obviously diseased seeds, 56 percent yielded this fungus; 44 percent yielded *Ascochyta rabiei*.

330. ZACHOS, D. G., C. G. PANAGOPOULOS, and S. A. MAKRIS. 1963. Researches on the biology, epidemiology, and the control of anthracnose of chickpea (in French). Annls. Inst. Phytopath. Benaki, N. S., 5 (2):167–192.

Report of laboratory and field studies on effect of temperature on germination of conidia of *Ascochyta rabiei*, 20 to 25° C (best at 25°) being opt. development of the fungus; time of incubation on chickpea leaves: 7 days at 13 to 16°, 5 at 18 to 25° C. Conidia collected in March remained viable through March and April, critical months for the disease in Greece, and perithecia formed on overwintered chickpea debris in January. Rapidly germinating ascospores were liberated from February onwards throughout the year. Variations in climate of different areas and in rainfall are important factors. Pycnidia are numerous on dried stem pieces in the field as well as on the leaf spots. Other legume crops were not susceptible.

Epidemiological and seed disinfection studies are reported. Formaldehyde, malachite green, arasan, and new improved granosan failed to give complete disinfection and disease foci soon spread in experimental plots, but a 12-hr treatment with 150 μg/ml pimarcin was completely successful.

331. ZALPOOR, N. 1963. *Mycosphaerella rabiei* Kovacevski (*Ascochyta rabiei*) (Pass.) Lab. (in Farsi). Ent. Phytop. Appl., Tehran 21:10–12.

A. rabiei was first seen in Kazvin in Iran in 1957. Later it caused severe damage to chickpea in Mazandaran and Gurgan. It constitutes a danger to crops in the Caspian region where the climate favors infection.

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